ENGINEERING RECORD

A WEEKLY JOURNAL DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

PUBLISHED BY THE MCGRAW PUBLISHING COMPANY, INC.

Volume 68 NEW YORK, SATURDAY, AUGUST 16, 1913 Number 7

The Soo Line Freight Terminal The Soo Line freight terminal in Chicago, described on page 188, seems to offer a very satisfactory solution to the difficult problem of establishing a large terminal in the heart of a busy city. The territory to be utilized is intersected by a number of streets, prohibiting a street-level layout. Local conditions required, therefore, the elevation of the tracks; but there were left the alternatives of filling the space between streets to the necessary track level and building the freight and warehouses on the new grade or of building a deck on which the tracks are laid, thus rendering practically all the space beneath available for storage. The authors of the article referred to do not give the relative estimated costs of the two schemes, but in any event the one chosen has two overwhelming advantages—the utilization of the entire ground-level space between streets and great flexibility for track arrangement. The accessibility of teams to the storage space would not have been possible with the buildings on fill at track level. Furthermore, these buildings and the bridges over the streets would, as the authors point out, have fixed within narrow limits the location of the tracks. Most of these buildings are eliminated by using the space under the track deck, and by making this deck of uniform design capable of supporting tracks as close together as they can be put, the opportunity is afforded to shift the tracks to meet any future needs. In fact, with the flat ballasted deck these track changes can be made with greater ease than could be possible with tracks laid on the ground, and for an expensive terminal that is expected to meet the changing requirements of several decades this flexibility is as important as it is unusual.

Public Works in the Philippines We are accustomed to look to the British Government for colonial engineering feats of an extensive sort—works that bring to savage and backward races the sanitary, housing and transportation advantages synonymous with civilization. The work done by British engineers in far-off colonies has indeed given them a well-deserved fame, but few in the United States, whether engineers or laymen, understand that works that can rank with the best in British colonial engineering history have been built by American engineers in the Philippines. The amount of work accomplished is almost incredible considering the conditions under the Spanish régime and that only 15 years have elapsed since the American occupation, during at least one-third of which warlike conditions were unfavorable to internal development. For this reason not only engineers but all who take a pride in American achievements will read with interest the article in this issue recording briefly what the American Government has accomplished in the Philippines in an engineering way. Under an efficient organization there have been constructed highways, bridges, public buildings, water supply systems and irrigation works—all according to high standards. In one respect the highway laws may well be taken as a model even here in the United States, for maintenance is placed above every other consideration. The system in use would not be applicable here without considerable modification, but certainly there is a middle ground between the Philippine system and the lack of maintenance organizations in the United States. A patrolman, or "caminero," equipped with road-making tools is assigned to every kilometer and broken stone and other materials are deposited at intervals along each section so that repairs can readily be made. A sub-foreman has charge of the work of each group of ten camineros, while a foreman supervises the sub-foremen on each individual road. Maintenance takes precedence over every other expenditure, and the district engineer is responsible for any deterioration of the roads of his district. For bridge and building work concrete has been adopted as the principal material, so that permanence and low maintenance costs are assured. All in all, the record is one of which the American people and the Bureau of Public Works, under its efficient director, Mr. Warwick Greene, may well be proud.

An Achievement in Construction When the superintendent of a gravity waterworks system finds each morning that his distributing reservoir does not refill during the night to the height of the previous morning's gage reading it is time to study conduit-carrying capacities and do something quickly. Such a condition arose at San Diego last May, and the "double-quick" methods of putting pipe together and of transporting pump and transformers, described elsewhere in this issue, remind one of the flood-relief measures at Dayton, where all the portable pump outfits in the vicinity were pressed into service to unwater basements and clogged sewers. Plenty of water in the mountain reservoirs but too-small conduit capacity to get it to town is the predicament of several Western cities. San Diego had plenty of water in the Morena and the two Otay reservoirs, but only one 24-in. line to town, and this not able to carry as much water as was used each day. An ordinary booster installation involving a by-pass line around a valve would have required a serious shutdown, and even after it was made there would have been danger from subjecting the line to a heavier pressure than that for which it was designed. In consequence an auxiliary line was decided upon. It required careful calculation to determine the point where a suction would not produce a vacuum, resulting in a disastrous collapse. Altogether, a neat hydraulic problem was presented to the waterworks officials, who pushed the construction with exceptional speed as soon as it was authorized. With a full stockyard and all the tools and equipment on hand, laying 2 miles of pipe in a week might not be such an extraordinary proceeding; but when pipe must be ordered from a distant city, even pipe tongs borrowed, specials cast in a day, bends made from larger sections of pipe, or turned with short bell-ends or large sleeves, it requires an efficient organization and co-operation from within as well as from without.

Water Department Reform The preceding note on the achievement of the San Diego water department calls to mind the reformation that vigorous management can bring about in a short time. In a note in the Engineering Record of March 2, 1912, attention was called to the absence of records in the San Diego department. The remedying of that condition was not as simple a matter as it might theoretically seem, for the "oldest employees" who carried valve locations "under their hats" were unwilling to give up their information, resulting finally in a strike. Following a strenuous period, during which 30-in. gate valves between high and low service mains seemed to open and close by thought transference, and the water-department officials became the best-known and most unpopular citizens, public data were recorded in public records, and the note referred to no longer applies to the town regarding which it was written. There are twenty-four books distributed throughout the department showing where every gate valve and fire hydrant in the system is located, its size and how it operates. Four complete sets of wall maps indicate the location and size of every main, gate and fitting. A loose-leaf-record system, corrected daily by the statistician, shows the location of services, meters and much other data. Nor was this the only difficulty confronting the department that year and calling for vigorous management. During 1912 the city grew so rapidly that every public-utility corporation and municipal department was taxed to its utmost to keep pace with the expansion. Service main extensions—in a city of 76,000, covering an area 27 miles long and 2 to 4 miles wide, with large unoccupied territory between built-up sections—ran to such large figures as 38.6 miles, 10 per cent of the total distribution system mileage. Moreover, the seasons of 1911 and 1912 were unusually dry, adding to the tension existing in the department for other reasons. Fortunately San Diego cannot be held up as a water-waste victims because the services are 100 per cent metered and the consumption last year averaged but 75 gal. per capita and 451 gal. per tap. Nevertheless, a city situated in a semi-arid section, where large natural lakes and constantly flowing rivers do not exist, naturally views with alarm shortage in the rainfall. Distant gorges must be relied upon to impound the winter runoff. Suffice it to say, however, that in the face of all these difficulties the department came through with credit. The old admonition to the traveler to San Diego "to take along a jug of water" happily has been without serious meaning within recent years and the present organization of the department indicates that the admonition will not again be needed.

Grasping Road Propaganda State good-roads associations, if they value their individual existence, should be on the lookout against the probability of being swallowed alive by the National Highway Association of South Yarmouth, Mass. That organization's ambition is no longer satisfied by mere contemplation of its pretty maps of ocean-to-ocean boulevards to be constructed at government expense. It seeks more than a letterhead existence, and it has already gathered to itself two state road organizations—the Ohio Good Roads Federation, whose moving spirit has become director of organization of the National Highway Association, and the newly born Pennsylvania Good Roads Association. Last week at Harrisburg less than thirty men, all in one breath, formed the Pennsylvania association, and voted to make it a division of the National Highway Association.

The two or three speakers who suggested that the state association should learn to walk before it tried to fly were voted down without ceremony, for the meeting was called by a body of gentlemen whose purpose it was to add another tail to the National Highway Association kite, and no other program was at all acceptable.

The Pennsylvania Motor Federation has long been the recognized and very effective good-roads organization of the state, but it evinced no desire to become a division of the highway association; hence the formation of the Pennsylvania Good Roads Association, whose birth and amalgamation with the national association were simultaneous.

It is only because of the announced intention at this meeting to gather in all the state organizations which can be induced to become its "divisions" that this notice is given of the absorbent propaganda of the National Highway Association.

Even if its plans for Federal roads across the continent were sound and practicable, there would still be many reasons why the independence of state organizations and their freedom to perform the work that is peculiarly their own should not be jeopardized by affiliation with a national body with which they can have little or nothing in common. When there is the added danger that such an affiliation and surrender of independence will carry with it committal to an extravagant program of road building by the Government it may perhaps seem wise to resist even the offer by the National Highway Association to pay salaries and rent offices for state associations which are willing to become its divisions. It will certainly be well to find out in advance just what it means to be one of these divisions, instead of entering blindly into a state of vassalage as was done by the organizers of the Pennsylvania Good Roads Association last week.

Demand for Results from Flood-Prevention Studies

The curing of headaches seems to have little analogy to the prevention of flood damage, but undercurrents in Ohio lead to the belief that there is a striking parallel. The man with an ache can go into the nearest drug store and get a powerful drug that will act like a charm. The result is satisfying and he does not stop to inquire further as to the disorder or the effect of the remedy. More than likely the cause has not been removed, the relief is temporary and the drug, while curing the headache, has had an injurious effect in other directions, or at least an insidious influence. To get at the root of the difficulty requires careful examination by a competent medical adviser and the prescription of the best remedy, all things considered.

In the cure of destructive floods somewhat similar conditions prevail. One can select the nearest and most apparent remedy—begin immediately after the subsidence of the waters to pile up huge levees, raze buildings by the score on the flood plain, enlarge bridge openings, or dig relief channels. Undoubtedly each of these measures would be of some help, but like unto the headache cure there are unanswered questions—in this case, as to the degree of immediate effectiveness, as to the suitability of the measure in relation to others that will be necessary and, above all, as to the sufficiency of the measure under the most severe conditions. The hasty measure apparently is apt to be ill advised, and, as in the case of the permanent cure for the headache, there is needed a careful diagnosis, and the remedy must be the best, all conditions being considered.

To determine the best remedy for destructive floods of large volume is not the work of one month, or even of six. It involves the collection of a vast amount of data, their digestion by competent specialists and the study and discussion by those specialists of all feasible plans, taking into account, among other things, efficacy, cost and speed of completion. Unless the original data are complete and reliable and the plans mature the permanent remedies may have the defects of the hasty ones.

While these views are readily accepted by an engineer, there is evidence from Ohio that the public feels that the plans should have been completed ere this and the dirt been flying. While the Engineering Record sympathizes with the views of those who realize the danger from a repetition of the Ohio and Indiana disaster and would deprecate any real procrastination, the work is going along as rapidly as is consistent with reliable results. It would be regrettable if popular clamor should result in hasty decisions based on inadequate data. The newspapers in the territory where flood-prevention studies are under way can do much to convince the public that no time is being lost, but that a satisfactory solution of the problem can only be reached through the painstaking studies now under way.

Fitting Engineering Students for Industrial Management

It is natural to expect that engineering colleges will sense the trend of industrial developments and adjust their curricula accordingly. The division of the fundamental engineering course of twenty-five years ago into the present courses of civil, mechanical, mining, electrical and chemical engineering is evidence of the influence upon the college of the specialization which has been brought about in engineering practice.

For many years the rate at which engineers have been taken from professional work into the management of railroads and industries has been increasing. This has been due to a recognition of the fact that a lawyer or business man is handicapped in handling large enterprises based essentially upon the work of the engineer. Unfortunately for the engineer, however, while he has decided advantages over the non-technical man because of his appreciation of the engineering factors, his training in economics, corporation organization and business law is generally not such as to give him the grasp necessary for the handling of the financial and executive affairs of a large corporation. In consequence those engineers who did have the broader grasp found lucrative and influential positions awaiting them. The deficiency mentioned has been clearly recognized by large interests, and lately there has been a well-defined demand for men who combined training in engineering and in corporation finance and administration.

Sensing the need, the alumni council of the Massachusetts Institute of Technology appointed a committee to consider the advisability of establishing such a course at the institute. That committee has now rendered its report. It states that in its opinion there is a real demand for "engineering graduates who have received, in addition to a fundamental training in science and engineering, instruction in business methods, business economics and business law," and that it is desirable to establish a new four-year course offering such a combined training.

In its specific recommendations the committee proposes that opportunity be given, by the establishment of options, for some degree of specialization along the lines of mechanical, chemical and civil engineering, and that the business studies should include thorough courses in political economy, economic history, economic geography, accounting and statistics, commercial and industrial organization, business law, banking and finance, as well as briefer courses in industrial psychology, argumentation and reports, taxation and insurance, transportation, and foreign trade. In addition, the usual humanistic courses would be retained, and in fact strengthened, by giving 60 per cent more time to English composition and literature than is devoted to them in the present engineering courses. About 59 per cent of the total time for the tentative course proposed would be devoted to science and engineering, 25 per cent to business studies and 16 per cent to general studies (English, history, languages, etc.). The business studies would be, to a large extent, grouped in the final year of the course.

Some question was raised while the committee was studying the problem as to the practicability of doing justice to both business and engineering studies in a four-year course. The committee points out that in the regular engineering courses not only are the fundamental principles of engineering studied, but considerable time is devoted to special work of a detail character. By substituting the economic studies for this special work, the committee believes that the proposed course cannot be regarded as superficial on either the engineering or business sides.

There is no doubt that the course proposed would give a training for which there is now considerable demand. Those who follow it should not only be well fitted by the mere knowledge obtained for entering industrial life on the executive side, but should also have a horizon as to corporation history, finance and management that should be invaluable. It does not, it is true, meet the criticisms of Dr. Steinmetz, which were commented on in these columns last week, but it certainly should produce men with much wider interests and grasp than those whose training is almost wholly technical.

Logic as Against Precedent in Writing Building Codes

Readers of the Engineering Record will recall that the New York building code has been through the throes of revision four different times—each time with abortive results. Another revision recently reported, judging by the comparatively little opposition to it, has more chance of passing than its predecessors, and, indeed, when judged in the light of the present temper of code framers, and even of some building department officials in Greater New York, it should be passed, for it is about as good a code as can be got under the ideals on which it is predicated.

While objection has been raised to it by various interests, it is, on the whole, a "clean" code. As an efficient and sane building law, however, it is woefully inadequate, and will so remain through a thousand revisions, as long as it is of the "specification type"—stipulating not what results are needed but by what means and materials certain results are to be attained. The recent revision like the present code and the abortive revisions is but a collection of the rulings and regulations made from time to time by the building superintendents of the various boroughs. These rulings necessarily relate to specific materials and types of construction, so that the code built up from these regulations necessarily is a mass—or mess—of minute stipulations as to what materials and constructions are permissible. Progress in the building art is so rapid that in many respects the code will be antiquated almost as soon as printed. It is beyond the power of human wisdom to draft a satisfactory code along such lines; but unfortunately laymen seem unable to understand that adequate regulation is possible without minutely stating what can and cannot be used or done.

The alternative is a very simple and brief code, setting forth the desired ends as to safety in construction, sufficiency of light and ventilation, sanitation, etc., and leaving to the superintendent of buildings to say what materials and constructions attain these ends. At this suggestion the cry immediately goes up that too much authority will be vested in one man, opening the way to discrimination and graft. The cry is preposterous, for aside from the ease of obtaining competent and upright engineers to exercise this authority it is possible to cast around it adequate safeguards. Furthermore, in New York itself the very practice of departmental rulings has worked with entire success and fairness, while the revision in hand is silent as to one great division of building work, necessitating on the part of the department the very regulation to which objection is made.

The existing code, for example, says nothing about concrete, and under the code, therefore, that material is not permissible. Its prohibition evidently would be an injustice to owners, and its use has therefore been allowed through departmental ruling, which briefly covers the chief requirements of safe concrete construction. The division of building work left by the new revision to the regulation of the department is that of sanitation. As in the past, even if the revision is adopted, the rules for plumbing will be formulated from time to time by the superintendent and thus will be kept abreast of the times.

To safeguard against discriminatory rulings the plan now followed by the department might well be stipulated in a general code such as here advocated. The practice is to publish proposed regulations in the "City Record" for a certain number of days, together with a notice of their proposed adoption, giving ample time for protest and public hearing. With the alertness of interests which might be adversely affected and the readiness of the daily press to take up charges against city officials there is little chance of an unfair ruling going through. In fact, it is more than likely that the material interests themselves will be at fault in trying to block rulings essential to safety and aimed against the use of inferior materials.

There is one particular, however, in which the new code must be heartily commended. It provides that before a building is occupied there be secured from the superintendent of buildings a certificate of occupancy showing for what purpose the building may be used. If authorized alterations are made subsequently a new certificate for the new use will be issued. At any time a structure is found being used for some purpose other than that allowed in the certificate the superintendent of buildings has the power to order the structure vacated. Heretofore it has not infrequently happened that a building permit would be secured for a structure of a certain class, but that the building would be used for some other purpose, which had it been specified in the application would have required a higher class of construction. For example, a non-fireproof building erected as a loft has been turned into a school which should have been fireproof, a non-fireproof residence into a sanatorium. Under the revision this evasion of the law will no longer be possible and one more danger to life from building accidents removed.

The proposed code, therefore, while as good as can be expected under present conditions, is far from ideal and should be superseded as soon after it is adopted as possible by a simple, logical code which does not attempt to embody all the building wisdom of the present—in itself an impossible task—and by so doing curb future progress.

Legal Specifications for Illuminating Gas

The production of illuminating gas of uniform character is so essential to good service and satisfactory relations between consumer and manufacturer that specifications prepared by municipalities covering this important commodity deserve careful study. Reasonable requirements and proper methods of testing gas for both its heating value and illuminating characteristics should be sought in preparing legal specifications to control the quality of the product, bearing in mind the importance of permitting efficient manufacture without sacrificing the legitimate needs of the user. A valuable paper upon this topic has lately been published by the U. S. Bureau of Standards, under the authorship of Messrs. E. B. Rosa and R. S. McBride, and this document will repay careful reading by municipal officers and engineers interested in gas ordinances and testing, and particularly in the analysis of errors occurring in gas calorimetry.

The authors point out that for most places the heating-value standard is preferable to candlepower regulation where only one of these is used, but advance the opinion that both the heating and lighting values should be legally maintained above certain minima in the interests of the consumer. The tendency in some quarters to disregard the open-flame burner is criticised, in spite of the rapid increase in the employment of mantles. With present methods coal and water gas manufactured on a heating-value basis also have a reasonable candlepower; but if the heating value alone is the criterion, the needs of the open-flame burner are liable soon to be overlooked. What is wanted is a wisely chosen mean, clearly specified and carefully maintained; but this best mean between gas too rich in illuminants for the best service with mantles or too poor for open-flame work is not everywhere the same, and the bureau believes that the state commissions should be authorized to fix values required and make exceptions for special reasons.

A valuable discussion of the merits of net and total heating value standards is included in the paper, which presents much material calculated to clear away misconceptions of terminology and to establish scientific methods of testing. The authors conclude that the net heat is, on the whole, the best measure of gas usefulness, as it depends only upon the quality of the gas, being unaffected by atmospheric conditions at the time of the test, and is easily measured experimentally. The only measurement required for the determination of the net heat not also required for determining the observed heat by calorimeter is the measurement of the quantity of water condensed during the burning of a cubic foot of gas, and this observation is easily made within 2 B.t.u., or the equivalent of 1 cc of drip. The total heat depends only upon the character of the gas, and when it is desired to use this it can be obtained from the measured value by a simple correction, the authors presenting a table covering a wide range of variations in humidity and room temperature. For ordinary work the observed heat value of gas is within 2 per cent of the total value. For the most precise work it appears that there is room for some improvement in calorimeter design, but the apparatus now available is adequate for all commercial requirements.

The bureau has recommended (in a previous publication) for official specification the monthly average heating value and candlepower of gas. The use of minimum allowable values for any one day is also deemed necessary, since large temporary variations in quality, density and pressure are certain to render unsatisfactory a gas which may be very good on the average. The allowance of a deficiency of 2 cp in any one day is set forth as proper, provided the gasmaker does not attempt to take undue advantage of this tolerance. At present it is customary to allow a deficiency of 50 B.t.u. in the heating value on any single day below the specified standard, but the bureau is of the opinion that this is probably too great for the best service and that improvements in gas manufacture will probably bring about more uniform conditions within a few years.

The last portion of the paper presents a helpful review of the problem of obtaining standard conditions in gas measurement, with a careful analysis of the influence of barometric pressure and temperature upon the quality of the product at the burner. Present practice assumes a standard temperature of 60 deg. Fahr. as the average, and if gas passes through the test meter at a different temperature there is no difficulty in applying the proper correction. In dealing with pressure, however, the proper method is to take the normal pressure at any given place as the average actual barometric pressure there. Thus, in a standard ordinance a cubic foot of gas will be defined as that amount of gas which occupies a volume of 1 cu. ft. at 60 deg. Fahr. when saturated with water at this temperature and under a pressure of the specified number of inches of mercury, which is taken as the mean barometric pressure of the city. Gas regulations should be so written that the value assigned to the standard used, whether it be a candle, pentane lamp, or other device, will be its average value, as nearly as practicable, corresponding to the mean barometric pressure of the place where it is used. If this procedure is adopted, the bureau expects, after making further investigations of the variation of candlepower with barometric pressure, to certify a pentane lamp for altitude. The bureau recommends that testing regulations specify that the candlepower of gas be measured with an open-flame burner, avoiding the use of the phrase "the burner best suited to the gas" and stating clearly the exact device to be employed. No extended consideration is given in the report to the limitation of sulphur, ammonia and hydrogen sulphide, as this topic was thoroughly covered in the bureau's circular on "State and Municipal Illuminating Gas Regulations." A coming edition of this, with the present publication, will be a useful addition to the engineering literature of the gas industry and will be welcomed by many engineers in offices which must deal with the gas specification problem.

Public Works in the Philippine Islands under the American Régime—Part I

Remarkable Progress in Constructing Roads, Bridges and Public Buildings

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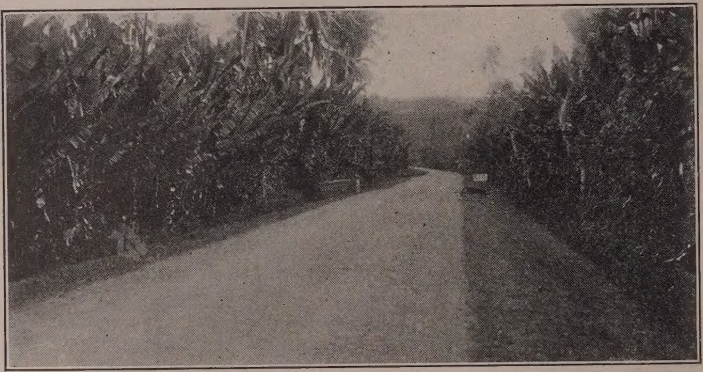
The Philippine Islands for the purposes of administration are separated into two governments—the Moro and the Civil The Moro Government is a military one, with headquarters at Zamboanga, Mindanao Island. The territory under this rule includes about two-thirds of Mindanao Island, together with the small groups of islands to the south and west of Mindanao. The inhabitants of this territory are chiefly Moros, who profess the Mohammedan religion, and a few wild tribes in the mountains. The governorship is held by an officer of the United States Army. The Civil Government has its headquarters at Manila, Luzon Island, from which point it governs all the Philippine Islands not included in the Moro Government. The population is chiefly Christian, speaking many different dialects, though there are non-Christians on some of the islands.

It is of the Civil Government's administration work that this article treats. The highest authority is vested in a governor-general, appointed by the President of the United States. The legislative power is vested in a legislature consisting of two houses—the Philippine Commission, appointed by the President of the United States, and the Philippine Assembly, which is an elective body representing the thirty-one Christian provinces into which the islands are divided.



Main Road across Island of Leyte

Caminero and His Road-Repair Tools

Civil Government

The administration of the Civil Government is divided into four executive departments—the departments of the Interior, of Commerce and Police, of Finance and Justice, and of Public Instruction. The secretaries of these departments are members of the Philippine Commission. Each department controls several bureaus, the directors of which are appointed by the governor-general.

Nearly all the public works in the Philippine Islands are executed under the Department of Commerce and Police, through its various bureaus; but a small proportion has been executed by the Department of the Interior, particularly among the wild tribes.

The principal construction bureau of the Department of Commerce and Police is the Bureau of Public Works, the organization of which consists of a director of public works, an assistant to the director, a chief engineer, a supervising engineer, and the responsible chiefs of the following divisions: Provincial, irrigation, engineering design, special projects, building, artesian well, automobile, statistical, accounting, property, record and law.

Of these divisions the provincial may be considered the most important from the fact that it executes practically all the construction work throughout the Philippine Islands, besides earning the money to carry on the bureau. This division has for its head a chief division engineer, who reports directly to the director of public works; four division engineers and thirty-one district engineers, one for each of the Christian provinces mentioned in the foregoing.

The chief division engineer and the division engineers are older men in the Philippine service, who have special qualifications gained through years of experience in these new conditions. The division engineers have their headquarters in Manila, but spend 75 per cent of their time in their respective divisions as advising and consulting engineers to the district engineers, and at the same time form a connecting link between the field men and the general office. This connection is very important, for some of the district offices are two or three weeks' travel from headquarters.

The district engineers reside in the provincial capitals and act in an advisory capacity to the provincial boards of their respective provinces. The responsibility for the construction work in the provinces is placed upon the district engineer, who has assistant engineers and skilled construction men to assist him.

The Bureau of Public Works in the Philippines is run on strictly business lines. For all work designed and executed under its supervision a varying charge of from 6 to 8 per cent is made. The actual superintendence is paid for by the municipalities or provinces involved, so that the total engineering and superintending charges on a project average about 15 per cent, dependent upon local conditions.

To give an idea of the amount and scope of the construction, the expenditures for the fiscal year 1912 are given: Roads and bridges, $2,500,000; buildings, $1,350,000; artesian wells, $200,000; irrigation, $250,000; miscellaneous works, $300,000. This work was designed and executed with a total engineering force of 118 men scattered over numerous islands, through a north and south length of 800 miles.

The most important work in amount expended is the road and bridge construction and maintenance. In taking up this work it must be distinctly understood that the roads in the Philippines are constructed at the expense of the Philippine Government and not with funds from the United States Government. Unquestionably there has been money expended for roads by the naval and military authorities for naval and military purposes solely that in no way assist in the economical development of the Philippines, while there is one instance in the early administration of these islands where money was appropriated for relief measures by the Federal Government; but for general purposes it can be stated that not one cent has been spent on the present road system in the Philippines by the United States Government.

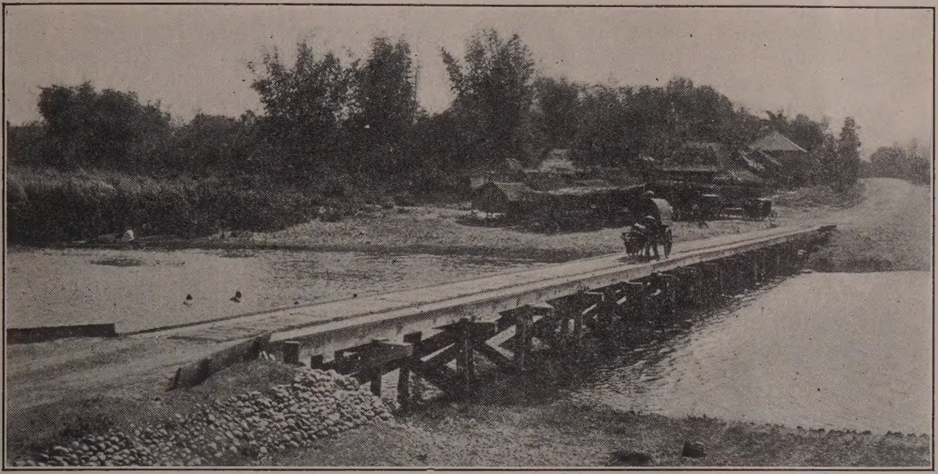
The good roads movement in the Philippines had its real beginning in 1908 while the present governor-general, Mr. W. Cameron Forbes, was Secretary of Commerce and Police, the department which controlled the preparation and execution of all public works in the thirty-one Christian provinces of the islands.

It was early recognized that the future of the Philippines was dependent upon the immediate development of its rich and extensive lands by means of railroads and durable types of roads, so that the products of these agricultural lands could quickly and cheaply be transported to the seaports. Accordingly a law was framed to provide revenues for this road development. For comprehensiveness and in securing practical results this law might serve as a model to many of the executive bodies in the United States that have been backward or lax in the good-roads movement. This law provided not only for the construction of a lasting and durable type of road, but, of still greater importance, for the maintenance of the completed road.

Good-Roads Law

The important provisions of this law are that each male over 18 and under 60 years of age pays an annual poll, or "cedula" tax, of $1, of which 50 cents goes into the road-and-bridge fund; that 10 per cent of the internal revenue collections and one-eighth of 1 per cent of the total land taxes go into the road-and-bridge fund; that the insular government appropriates annually $250,000, to be distributed among the different provinces on a population basis, and that an annual insular government appropriation of $8,750 is made yearly for prizes to foremen and camineros for excellence in maintenance work.

These revenues are deposited with the treasurer of the province in which collection is made and can be spent only in that province. Under this law there is an assured annual fund available for roads and bridges of $2,000,000, to which there is generally added from $500,000 to $1,000,000 by special allotments



Collapsible Wooden Bridge, Pangasinan Province

The deck is in sections, tied together with cables and anchored on shore. It is not fastened to the bents and is raised by the floods and floated downstream until the subsidence of the waters, when it is swung to place and replaced on the bents.

from municipal, provincial or insular sources.

That the Filipino people were appreciative of the good roads was made apparent in a substantial manner. The original annual poll tax was only 50 cents. The provincial boards of each of the provinces, one after another, requested approval from the governor-general to double this tax to the present amount of $1. Next they took an option, provided for by law, of increasing their land tax to the maximum, which gave still larger sums for public works. Many of the provincial boards have voted large sums from general funds for roads and bridges, while the Philippine Assembly, which is the most representative body in these islands, being composed wholly of Filipinos, has made such generous appropriations for good roads and is so insistent upon the approval of these appropriations by the Philippine Commission (the governing body appointed by the President of the United States) that this body is placed in a somewhat embarrassing position, as the commission believes that there are other matters as important as good roads for which money should be spent.

The Philippine Commission, in order to assist in this demand for more roads on the part of the Filipinos, recently outlined a plan whereby loans can be made to municipalities or provinces for public-works purposes at 3 per cent per annum. For road construction these loans are refundable in two yearly payments, while for permanent bridges they are refundable in ten yearly payments. Although this aid has been available only two years, about $10,000,000 has been loaned, principally for the construction of roads and bridges.

Roads under Spanish Régime

The road system left by the Spanish régime consisted mainly of scattered roads throughout the islands, but with wide rights of ways. The alignment of these roads were, as a rule, good, and the American engineers have followed them, with changes in gradient and type of construction only. The few lasting types of roads left by the Spanish engineers were Belgian block, cobblestone, and cut adobe. The Belgian-block pavements were found in the seaport towns, and were usually made of granite brought over from China in ballast. In some of the smaller towns local rock was used.

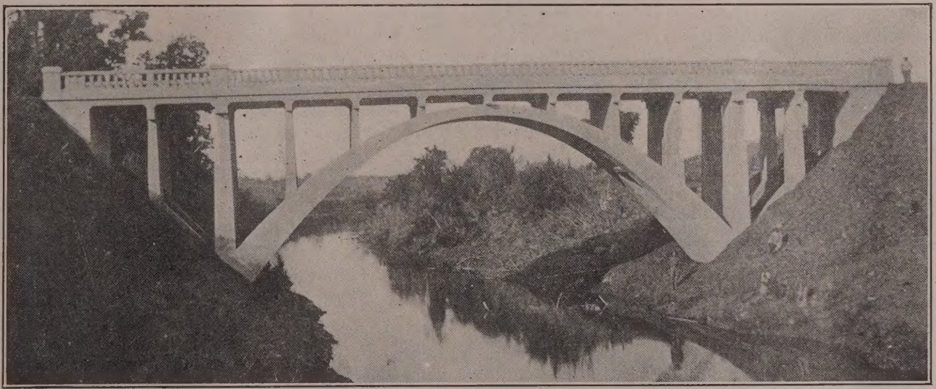
The cobblestone pavements were constructed of river boulders, with marked differences in size and wearing qualities. The main value of this type of road now is as a foundation or as a metal supply for the modern type of highway.

The cut adobe pavement was made of large rectangular blocks, 8 x 8 x 20 in., of a common volcanic rock called adobe, which is quarried with bars and then trimmed to the proper size with adzes or large bolos (Filipino working knives). This material comes from the quarry quite soft but hardens with exposure to the air. For light traffic it makes a good pavement.

The remaining Spanish roads were generally constructed of the material adjoining the right-of-way, and were passable only in the dry season.

Present Types of Road

The roads of the early American administration were of clay, sand and clay, coral, or gravel and were modeled after the prevalent types in the United States. It was soon discovered that the heavy crown could not withstand the terrific rains of the tropics, with a Philippine rain record of 46 in. in one day and 88 in. in four days (July, 1911), so that the present construction has a maximum crown of ½ in. to the foot for all types of pavement.



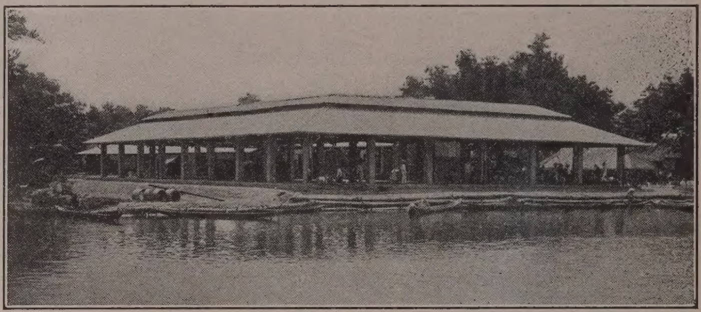
Modern Concrete Bridge which Replaced a Bamboo Raft

Practically all highway construction in the Philippines now consists of either plain macadam, Telford macadam, oiled macadam or asphalt. The oiled macadam and asphaltic pavements are meeting the present-day traffic conditions better than other types. There are, however, many construction disadvantages for these two types of pavements in the Philippines that make the cost disproportionately large and the construction progress slow. Due to the heavy and long rainy season and the long period of ground saturation following the economical working season lasts only from March to June. The lack of oil storage tanks in the Philippines, which forbids the importation of bituminous products in tank steamers, necessitates the handling in barrels. This is not economical for storing large quanities because of the heavy loss that occurs in storage and transportation. Therefore the government is now conducting experiments in the Bureau of Science with Philippine clays and shales to see if the vitrified brick pavement will not prove the permanent highway pavement of the Philippines. The low labor cost, both in the manufacture of the brick and in construction,

Reinforced-Concrete Bridge, Baloc-Cabanatuan Road

is expected to be an important factor in the economy of this class of pavement.

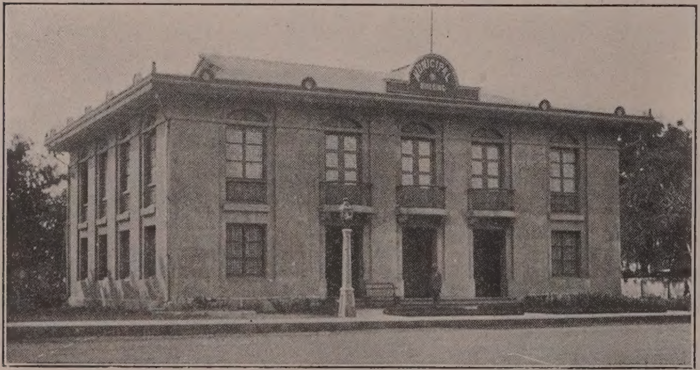
Primary-Intermediate School in the Philippines



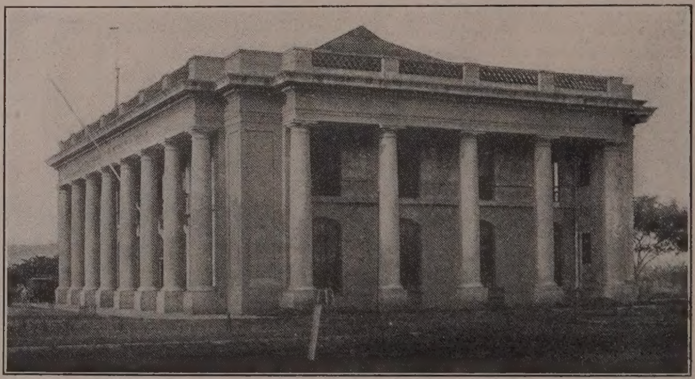
Type of Philippine Market Building

BRIDGES

The bridge work in the Philippines has been a wonderful educator to the American engineer. At the beginning of the American administration no reliable hydrographic records were in existence. Due to the different dialects spoken throughout the islands, and the difficulty in transmitting one's questions correctly through two or three different linguistic mediums to the oldest inhabitants, the information received was sometimes of so startling a nature that the engineer in the past made a guess, based on experience in the United States, as to probable waterway required and constructed the bridge. It was very hard to conceive that a stream bed which was dry or had a flow of only a few second-feet ten months in the year could upon occasion rise 40 or 50 ft., and attain a width of half a mile or a mile, and that the stream bed material could be in movement during this period for 30 or 40 ft. below the normal stream bed; but such has been the sad experience of the guessing engineers. Under the present régime no guessing is allowed. All questions pertaining to size, location, type and foundations are determined from strict engineering investigations and studies and all data are filed over the engineer's signature.



Municipal Building, Constructed of Concrete



Provincial Building, La Laguna Province

Under the present laws no wooden bridges are constructed unless approved by the governor-general, and then only for very exceptional reasons. Steel bridges are allowed when a reinforced-concrete type is impossible or the first cost is excessive, based on their respective lives. Many of the roads are coastal and the action of the salt water in the tropics is especially severe on steel bridges. Accordingly the reinforced-concrete bridge is the prevailing type, with an occasional steel or wooden bridge.

In reinforced-concrete bridges many types of design have been used, the most economical for the location in question being approved. The type which seems best adapted to Philippine conditions is the reinforced-concrete-pile bent, with reinforced-concrete deck of girders and slabs.

COLLAPSIBLE WOODEN BRIDGE

A wooden collapsible deck structure has proved a practical solution for bridging rivers with wide flood plains that could not be spanned permanently on account of the extraordinary cost or for other reasons. Hardwood piles are driven to refusal, cut off about 5 ft. above low water, and capped. Each span is bridged by a pine timber deck. The two approach spans are firmly tied to a deadman or shore anchor. Then each succeeding deck span is tied loosely with wire to the adjoining one until the middle spans meet, where no fastening is placed.

As the flood rises the deck sections are lifted free of the caps, divide in midstream, and the two strings of connected decks, pivoting on the shore anchors, are lined on the downstream bank. During the subsidence of the flood a few men keep pushing the deck spans into the stream and at low water they are floated back to their original location and lifted by a light derrick to their position on the bents. The length of the bridge is determined by watching the current flow at cap elevation during flood time, noting the limits where there is practically no current flow, and building an approach to this point.

MAINTENANCE OF ROADS AND BRIDGES

The maintenance system for these roads and bridges is known as the "caminero system." In brief, it consists of a man, equipped with wheelbarrow, shovel, rake, tamp, grasshook and other roadmaking equipment, for each kilometer of road. Twenty cubic meters of road-mending material are deposited at intervals along each kilometer for the caminero's use in repair work. There is a capataz, or sub-foreman, for each ten camineros, who covers his section by bicycle or horseback, instructing and directing the efforts of the caminero. A foreman mounted on bicycle or wagon supervises the sub-foreman of each individual road, where the length does not exceed 50 kilometers, while a general foreman with a motorcycle or team is responsible for the maintenance work of the entire province. These men are almost wholly Filipinos—according to the policy of the United States Government—who have been trained by the engineers.

Under the Philippine laws maintenance of completed roads takes precedence over every other expenditure, and the district engineer is held responsible for any deterioration in the roads of his district, as the annual budget must be submitted by him.

On account of the low price of labor, which ranges from 20 cents to 40 cents a day, dependent on the locality, this effective system of maintenance is possible in the Philippines where it might not be in the United States.

The comprehensive road system for the Philippines was very carefully studied and planned in 1907 and 1908. The existing Spanish road laws were gone into thoroughly, were retained where good, and added to where deemed necessary. Laws were framed to provide road funds and the collection of same. The question of maintenance was definitely settled as to methods, relative position and awards for excellence.

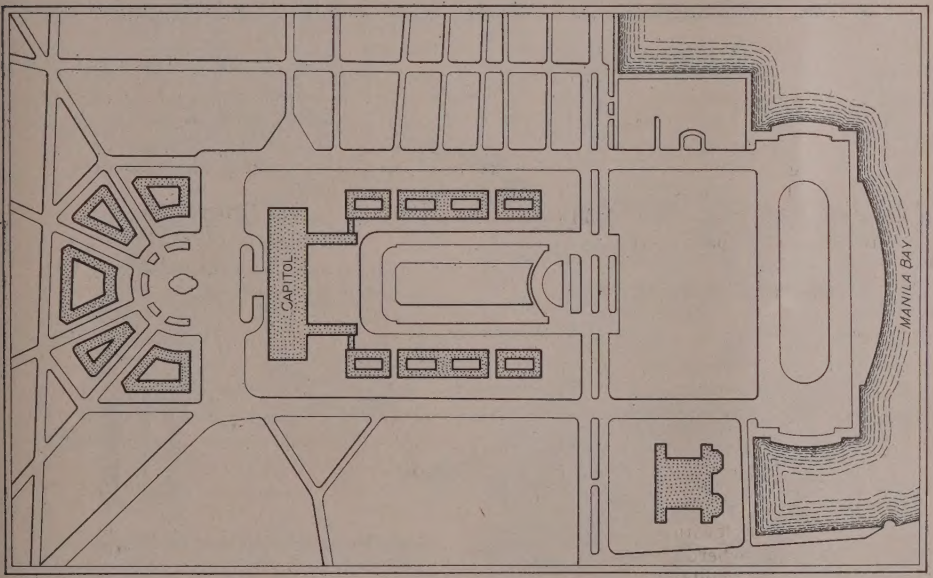
Five years of practical application of these laws have proved conclusively the wisdom and foresight of the promoters of this important economic movement in the Philippines. As a working model these laws were excellent. As an educator of the Philipino public and a developer of the agricultural resources, the good-roads movement has proved an unquestionable success.

Under the above-described organization there have been constructed up to Jan. 1, 1913, a total of 1805 kilometers of first-class roads, 2200 kilometers of second-class, or improved, roads; 3200 kilometers of foot or horse trails in the foothill or mountain districts, and 6233 bridge structures having a span of 26,000 meters (16 miles), of which 5177 are of a permanent nature. During the same period there have been maintained more than 4000 kilometers of road annually at a unit cost of $250.

BUILDINGS

The building construction has from necessity received considerable attention. The Spanish public structures were either of native timber or of the adobe rock mentioned in the foregoing. Because of the action of dry rot, white ants and other borers, earthquakes, typhoons, and poor foundation work, most of the public buildings of Spanish erection are either unusable or about to become so shortly. This naturally requires activity on the part of the municipal, provincial and insular officials looking toward replacement of these structures.

The Philippine law provides for the position of consulting architect to the Philippine Commission. Under its provisions the consulting architect is responsible for both the design and construction of all public buildings in the Philippine Islands, and no design can be executed without his approval. In practice, however, almost all structures outside of Manila are erected under the supervision of the district engineer, who is required to assume this responsibility.



Proposed Capitol Development for the Philippine Islands

Like bridge construction, all new building construction is of a permanent nature, and accordingly reinforced concrete and structural steel are almost the only materials used, the former predominating.

Public buildings to date have been constructed for hospitals, custom houses, the university, public schools, government offices, government warehouses, provincial capitols, provincials jails, soldiers' barracks, municipal markets, municipal offices, etc. These structures vary in cost from a 7 x 9-meter school building at $1,100 to the Philippine General Hospital at $300,000.

The Bureau of Education requires the greatest number of buildings. This bureau has adopted nine standard designs of intermediate and trade-school buildings that are adapted for the "unit" system of construction, whereby additions may be made without injury to the original structure. These range in size from 63-sq. m. floor area, with accommodations for fifty pupils, to a floor area of 1300 sq. m., accommodating one thousand pupils and costing $17,000. These buildings are going up in the most inaccessible parts of the islands, and in a few years there will be no municipality without its permanent school structure to act as a model for better municipal buildings.

Another type of building that has aroused public enthusiasm is the municipal market. The sanitary requirements of the Bureau of Health practically exclude the filthy native markets permitted during the Spanish régime. The Executive Bureau also has proved to municipal officials that the standard modern reinforced-concrete market is a revenue producer worth considering. Consequently the municipalities throughout the islands are selecting sites that permit of better sanitation, upon which will be erected modern markets. These markets are large open affairs, constructed of reinforced-concrete posts supporting an overhanging tile roof. The floors are of concrete suitably graded for drainage, the tables and booths being constructed of the same material.

Provincial capital buildings and modern provincial jails have also received the attention of the provincial officials, and some of the provincial centers have been made very attractive.

CAPITOL GROUP

The insular government has taken the preliminary steps toward the construction of a proposed capitol for the Philippine Islands at Manila, that when executed will incite the now awakened Filipino public to better and finer civic centers than is now the case. An appropriation of $50,000 has been made and a capitol committee appointed, with authority to prepare plans and estimates.

The site for the capitol was selected by the late D. H. Burnham when in Manila preparing plans for the beautifying of the city. It has a splendid frontage to the west on Manila Bay and provides for extensive public gardens between the buildings and the water.

The group of buildings consists of the capitol proper, for use of the legislature and executive offices, and other buildings, architecturally subordinate to the capitol, intended for the various bureaus of the government. The group is in the form of a great court and open on the side facing the bay. This court is divided into two parts—a Great Court, 200 meters in width, with the bureau buildings extending along both sides, and the Court of Honor, 120 meters in width, inclosed between the wings of the capitol. The Court of Honor will be 3 meters higher than the Great Court and will be approached by steps for almost its entire width.

The buildings intended for the bureaus are separate structures, six facing the rectangle west of the capitol and five facing the semicircle on the east.

The style adopted for the entire group is Roman classic, which had its birth in a warm climate, and its use, therefore, in a tropical country is considered correct. In the plans submitted all the buildings are surrounded with double walls in the form of colonnades to serve as a protection from the sun and storms. For the sake of dignity the entire group of buildings will set upon a basement 4 meters in height. The construction throughout is to be of non-combustible materials, to be as earthquake-proof as modern engineering science can devise.

The columns of the porticos and porches, for the sake of appearance, will be of marble or granite, while the exteriors of all the buildings will be of reinforced concrete.

Where wood is used, especially in the floors, doors, and windows, it will be of selected Philippine hardwoods.

The buildings will eventually be embellished, both the exterior and interior, with numerous statues and mural decorations produced from time to time by Filipino sculptors and painters of recognized ability.

Mr. William E. Parsons, consulting architect to the Philippine Commission, prepared the capitol group plans, and his estimated cost to complete it approximates $3,000,000. The completion of this work will satisfy a long-felt want among the bureaus now scattered all over the city of Manila in cramped and poorly arranged buildings.

(To be concluded)

Municipal Control of City Planning in England

Sheffield, England, is a city of about 475,000 population. The area included within the city limits is practically 25,000 acres. While this does not give an excessively high average population per acre as compared with some American cities, the conformation of the English city is such as to crowd the larger number of its residents into the five main valleys that lie within its limits and leave unpopulated the steep slopes of the surrounding hills. Realization of the need of a better distribution of the dwellings in this and other English cities led Parliament to pass the Housing and Town Planning Act. One of the most important features of this legislative enactment is the power conferred upon the authorities of limiting the number of houses to be built to the acre. While town planning, from a legislative point of view, is yet in its infancy even in England, the advantage of constitutional authority for this restriction and the methods of achieving good results therefrom are forcibly set forth in a paper by Mr. Charles F. Wike, city surveyor of Sheffield, at a conference held by the Institution of Municipal and County Engineers, July 16-17. This work was done previous to the action of Parliament and is now forming the basis for greater plans.

ESTATE DEVELOPMENT

One of the first steps which the municipality of Sheffield took toward town planning was in the year 1900, when it purchased what is known as the High Wincobank estate, containing about 60 acres.

The estate is in a good position, on account of its elevation, and is very convenient for housing purposes. The greater portion of it is fairly level, and lies within a few minutes' walk of the rapid transit terminus. It is also near Firth Park, and within comparatively easy reach of some of the large engineering works where many thousands of men are employed. It is nearly 400 ft. above sea level, and commands views of some very good scenery. A scheme was prepared for laying out the estate, and the site has been laid out strictly in view of future development of the surrounding estates and district.

Arrangement of Dwellings

Before erecting any houses it was agreed that every house should have an area of 200 sq. yd. of land appropriated to it, exclusive of streets. Competitive plans were advertised for, and fifty-three cottages were erected by the municipality in accordance with the plan adjudged by the assessor to be the best, but modified to insure compliance with the local laws. These dwellings were erected to form a quadrangle, in the center of which is a "green," instead of a garden to each house. This was considered to be a much more satisfactory arrangement than the provision of a garden at the rear of each house, as the general appearance of the houses is often very much deteriorated if the gardens are not kept tidy. The gardens also in time have to accommodate a variety of wooden and other structures. These often become dilapidated, and are erected without any attempt at uniformity or suitability. These municipal greens are common to all the houses and are maintained and looked after by the city. They give plenty of light and air to the dwellings, and form a recreation ground for the children. If gardens are required, the tenants can obtain them by taking allotments provided by the authorities on the estate a short distance from their homes. Thirty-five additional houses of similar construction were afterward erected, and subsequently twenty cottages, to let at a rental of $1.25 per week, and twenty-three combined cottages and tenements which were designed and built by a local architect. The rents of the cottages on the estate vary from $1.25 to $2.50 per week, and the flats are let at $1 per week, including taxes.

Cottage Exhibition

In 1905 and 1906 various conferences were held under the auspices of the National Housing Reform Council, and it was decided to hold a cottage exhibition in Sheffield. The Sheffield city council was approached on the matter, and as a result a portion of the estate (about 25 acres) was set apart for the purpose of an exhibition. A site-planning competition was then decided upon, one of the conditions being that the average number of houses for the whole exhibition area was to be twelve to the acre, inclusive of streets. The laying out of the site was carried out in accordance with the prize plan. A portion of the land utilized for the exhibition held in the autumn of 1907 was leased to builders in plots, and forty-four cottages were erected, divided into three classes—Class A at a price not exceeding $875, Class B at a price not exceeding $1,000, Class C at a price not exceeding $1,225, these prices to include architects' fees and builders' profits, but not the cost of land or roads. The cottages were afterward purchased by the city, one of the conditions of the competition being that the competitors should sell at the price stated for the particular class of cottage. This condition was really a very essential one, because in some competitions in other towns prizes have been awarded for houses which could not possibly be built at the prices stated. The population of the estate is about 800.

Two Shops Erected

Toward the end of the year 1907 a special committee was appointed to consider and report on the further development of the estate. In accordance with their instructions a plan was prepared showing the development of the estate, which was approved, and it was decided, subject to the approval of the local government board, to lease the undeveloped land in plots to builders. The local government board, however, declined to sanction this proposal, and until recently no further steps were taken. The city is now erecting fifty-three more dwelling houses and two shops, the latter being a new departure in the development of the estate. About 17½ acres of the estate are let to tenants and others as allotment gardens. This is at present the best way of dealing with this part of the estate, as, until a sewer is constructed through the adjoining valley, there is difficulty in draining this portion to the sewage works.

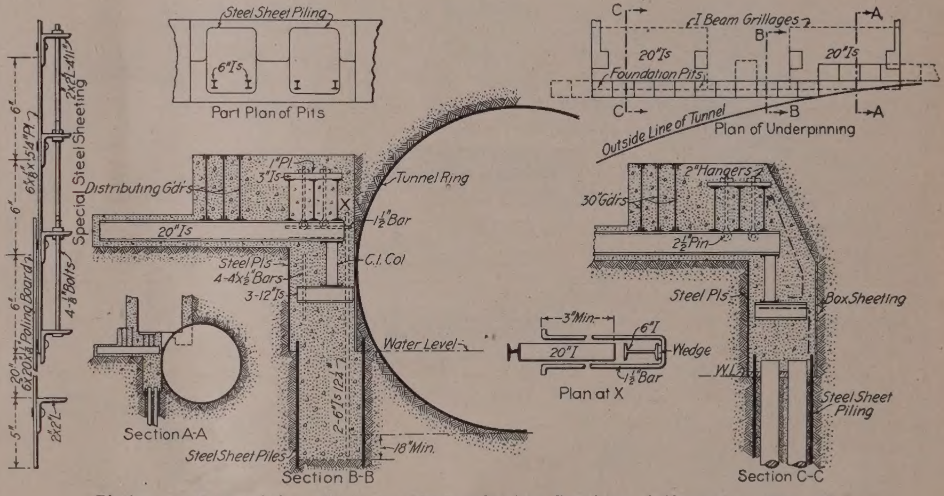
Another estate, which the city council purchased about eleven or twelve years ago, is the High Storrs estate, with an area of about 74½ acres. It was purchased, partly by agreement and partly under compulsory powers, for housing purposes. Several schemes were prepared, none of them having yet been adopted, the council having decided to defer the matter until the schemes in the other parts of the city are more developed. A new road 4800 ft. long and 50 ft. wide, from Whiteley Woods to Ringinglowe Road, connecting two residential districts, has been roughly laid out, providing work for about one hundred unemployed workmen. A portion of the land is utilized for playing fields in connection with the education committee's schools, the remainder being let for agricultural purposes and allotment gardens.

A further step in the direction of town planning was taken by the city a few years ago, when the new Rivelin Valley Road was laid out. The city council was already owner of the stream, mills, and water rights through the valley, which is about 3 miles long. These were contained in a narrow strip of land, with an area of about 40 or 50 acres, but this has been doubled by various purchases. The road was then constructed, and has been a great improvement, as apart from the development of the land it has opened out a valley with great natural beauty to the thickly populated district of Hillsboro.

Underpinning and Retaining Grillage Foundations

The thirteen-story "Evening Post" Building has a frontage of 75 ft. on Vesey Street, New York City, with four steel wall columns seated in pairs on 5-ft. box girders distributing their loads over large grillages in the sand 30 ft. below the surface of the street. The 20-in. I-beams forming the grillages are inclosed in a solid mass of concrete and are arranged at right angles to the building line. They project 4 ft. beyond it and are arranged in grillages 28 ft. long parallel to the building line and about 19 ft. apart in the clear.

Section 1A of the Lexington Avenue Subway passes through Vesey Street in front of the building, with the curved alignment of one of its single-track tunnel tubes located so that the axis of the tube is oblique to the building line and about 2 ft. below the bottoms of the grillages, thus bringing the cast-iron tunnel lining within 12 in. of the grillage and subgrade 12 ft. below at the east end of the building and 18 ft. away and 10 ft. below it at the west end. The soil is very fine sand bearing water at about 2 ft. above the elevation of subgrade, and the excavation approaches so close to and below the grillages that there was serious danger of undermining them in spite of the precautions taken to prevent bleeding into the tunnel as described in the Engineering Record of Aug. 9, 1913, page 147.



Girders and Retaining Wall for Underpinning Sections Adjacent to Tunnel

It was, therefore, determined to retain the sand under ends of the grillage beams by a heavy concrete wall carried below subgrade of the tunnel and to give additional support to ends of the grillage beams by suspending them from girders parallel to the building line and supported on concreted pits driven below subgrade of the tunnel excavation. This work was accordingly executed in advance of the tunnel driving, as here described.

Suspending Grillage Beams

Beyond the building line the ends of the grillage beams were uncovered, the concrete between them was removed to a depth of 12 in., and three lines of continuous lattice girders, 30 in. deep and 75 ft. long, were assembled in position on the top flanges of the grillage beams parallel to the building line. The girders have 6 x 6-in. flange angles bolted together and bolted to the web members and were supported on the tops of the grillages preparatory to underpinning. The space between the grillages was filled with concrete reinforced by longitudinal rods.

In each space between the grillage beams a vertical 2-in. eyebolt was placed between the lattice girders, with a 2½-in. horizontal pin perpendicular to the grillage beams passing through the eye and engaging the undersurface of the top flanges of the grillage beams. The nuts on the upper ends of the eyebolts were screwed to bearing on 12 x 12 x 1-in. reaction plates and 3-in. transverse I-beams with reinforced webs seated on the top flanges of the lattice girders. The nuts were adjusted to transfer part of the grillage load to the lattice girders, the latter being concreted solid.

Retaining Wall under Grillage Beams

In alternate spaces from end to end of the building 5 x 5-ft. pits extending 3 ft. under the ends of the grillage beams were sheeted to ground-water line. On the side toward the building the sheeting consisted of overlapping ⅛-in. steel plates, with horizontal transverse angles countersunk riveted to their inner faces. The other three sides of the pits were inclosed by horizontal wooden box sheeting. Below water line the dimensions of the pit were reduced to 4 x 3 ft., and were sheeted with 7-in. Lackawanna steel sheet piles 6 ft. 6 in. long, provided in the center of each transverse side of the pit with a special T-shaped piece and an extra closure pile forming part of the sheeting later driven to connect adjacent pits, and making a continuous line of steel piling from end to end of the building.

The 4 x 3-ft. pits were concreted, keyways being formed in them to bond with the concrete subsequently placed in excavations made between adjacent pits, and thus forming a continuous wall. The concrete was carried up to within 3 ft. of the grillage beams and on it were set horizontal 12-in. I-beams to provide bearings for vertical cast-iron columns, with their ends engaging horizontal channel webs and wedged up against the grillage beams.

The wall was reinforced against horizontal pressure by pairs of vertical 6-in. I-beams in each pit that were set on the bottom of the excavation and had their upper ends connected to the grillage beams by special bent U-bars and wedges as shown in the sketch. The I-beams were concreted and grouted in position and pits were sunk and steel sheeting driven under the adjacent buildings to prevent any movement of sand around the ends of the "Evening Post" Building.

This work was designed and executed, subject to the approval of the Public Service Commission, of which Mr. Alfred Craven is chief engineer and Mr. Robert Ridgeway engineer of subway construction, by Frederick L. Cranford, Inc., contractor for Section 1A.

Islais Creek Incinerator at San Francisco

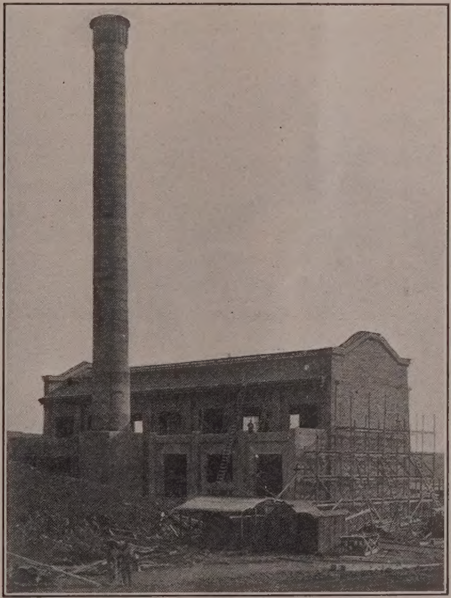
Municipal Plant Embodying the Latest Ideas in Incinerator Practice

San Francisco is just completing a municipal incinerator which will be one of the most efficient and modern in the United States.

As early as 1908 the purchase and enlargement of the Sanitary Reduction Works, a privately owned incinerating plant, was contemplated by the city. A study was made of the refuse collected at that time; and calculating the probable increase in population and the proportionate increase in refuse, it was decided that the plant of the Sanitary Reduction Works was entirely inadequate. Partial results of the investigation conducted in 1908 and 1909 are given in Table 1.

The average amount of refuse collected per week day for the above nineteen weeks was 440 tons.

The weights of refuse given in Table 1 were obtained by weighing each load separately on a wagon scale as it was delivered to the plant of the Sanitary Reduction Works. The volumes were obtained by measuring the capacity of the wagons and estimating the excess or deficiency of the volume of the refuse contained therein. The quantities of ashes, garbage and rubbish composing the refuse were obtained by estimating by observation the relative proportion of the components as the wagon loads were dumped into the bunkers.



Main Incinerator Building

The number of dead animals disposed of by reduction during 1907, 1908 and 1909 are shown in Table 2.

The percentage of combustibles, incombustibles and moisture and the heating values given in Table 4 were obtained by experiments, as follows: Small samples were taken at random from each load as it was dumped into the receiving bins, and all the samples collected from the loads from each section during the day were thrown into a pile. This pile was then thoroughly mixed and divided until a sample of about 1 cu. ft. was taken. This was chopped up, mixed and divided until a sample of 1 quart was obtained. This was dried in a small oven until no further reduction of weight was observed, thus determining the moisture. The combustible was then determined from these samples in a chemical laboratory, the heating value being determined by a bomb calorimeter.

On the basis of all of the data secured in these investigations the following figures were adopted as a basis for design:

	Tons per day
Maximum quantity of refuse collected..............	581
Average quantity of refuse collected in 1908.......	433
Quantity in immediate future (estimated)..........	480
Quantity per day in remote future (estimated).....	1400

Present and Proposed Installation

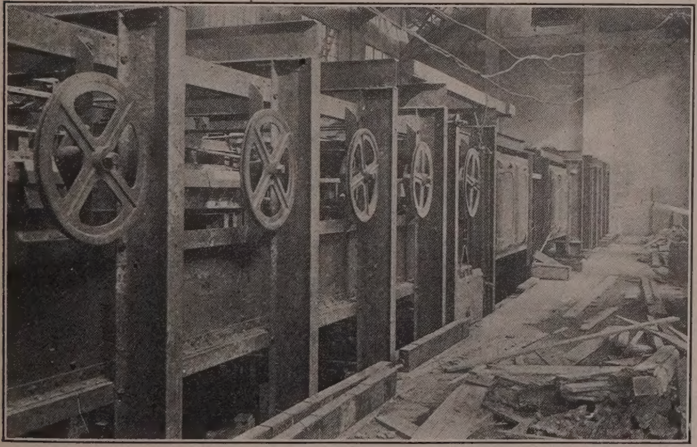
The capacity of the proposed present installation is 480 tons per day, and 1380 tons per day will be provided for eventually.

In 1911 and 1912 two new incinerators were designed, one to be located in the Potrero district and one in the North Beach section. The former, known as the Islais Creek incinerator, is practically completed and will be tested early in September. This plant has a capacity of 120 tons per day. The North Beach incinerator will probably have a capacity of 360 tons per day.

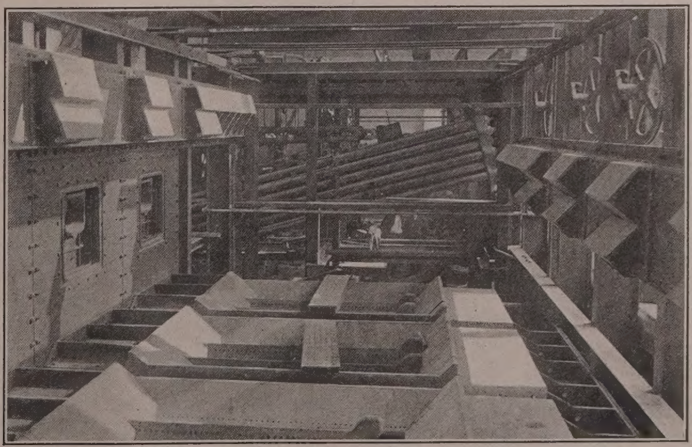
The Sanitary Reduction Works incinerator has been purchased by the city for $400,000. The plant included in this purchase, however, will not be used when the new incinerators are in operation, as its equipment is obsolete and the smoke produced is excessive.

Islais Creek Incinerator

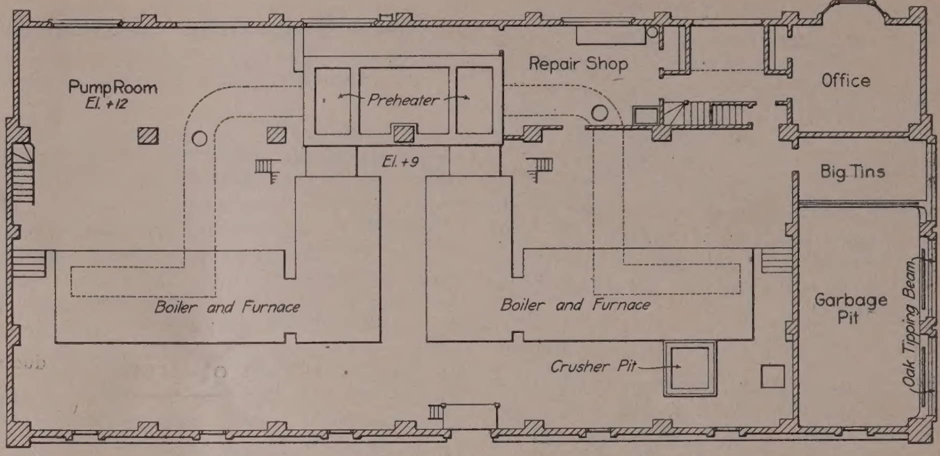
The Islais Creek plant consists of two separate buildings. The larger is 122 ft. 6 in. x 54 ft. 2 in., and contains the furnaces, boilers,



Incinerator Furnaces at Stoking Level



Combustion Grates for Islais Creek Plant



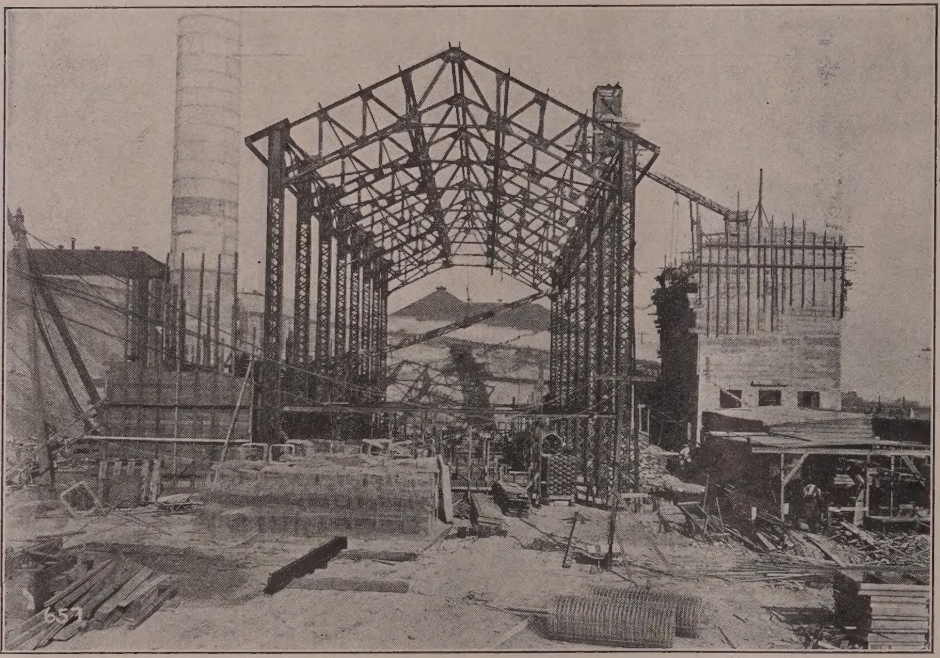
Plan of Clinker Floor, Showing Arrangement of Plant

preheaters, laboratory, men's room and offices. Beneath it is the garbage pit and oil tank.

The architecture is of the Mission style, the structure being of reinforced concrete, with a steel frame. The reinforced-concrete stack, 154 ft. 6 in. in height and 17 ft. inside diameter, adjoins on the north side, while on the south side a tunnel 6 ft. 6 in. x 9 ft. in cross-section and 25 ft. in length connects with the clinker storage building. This is a two-story reinforced-concrete structure, 52 ft. 6 in. x 26 ft. in plan. It contains the clinker storage bins, hydraulic accumulator, baling press for tins and similar material, a shower and locker room, storeroom and toilet. Both buildings are absolutely fireproof.

The main building is ventilated by a series of ducts through which the air is drawn from the upper portions and from all parts where there might otherwise be an accumulation of dust. The ducts lead to the forced-draft fans, which deliver the air into the preheaters.

There are eight grates on which refuse is consumed without any additional fuel. Above each grate is a drying screen, to which refuse is fed from separate containers. Each 60-ton unit is provided with a water-tube boiler of 1700-sq. ft. heating surface. The boilers are equipped with Foster superheaters, which will furnish 100-deg. superheat. The superheaters are of the armored type. They require no flooding or other special attention. In them the air is heated by utilization of the gases leaving the boilers. From the preheaters the air is forced over the white-hot clinker piles, and then to the furnace grates, where it supports combustion.



Reinforced-Concrete Chimney and Steel Frame for Main Building

Table 1—Amount of Refuse Collected Daily, Unit Weight, and the Estimated Quantities of Ashes, Garbage and Rubbish

Collections for the week ended	Estimated quantities in cu. ft. Ashes	Garbage	Rubbish	Average unit weight of refuse, in lb. per cu. ft., for the week	Average for the week, in tons, of refuse collected per week day
1908					
Oct. 17	4,377	47,232	126,750	29.5	435
Oct. 24	3,857	47,962	128,589	27.1	404
Oct. 31	3,845	50,911	124,789	27.2	405
Nov. 7	5,216	57,150	118,104	28.0	419
Nov. 14	5,529	65,202	105,862	27.9	408
Nov. 21	4,541	63,083	109,436	28.2	413
Nov. 28	8,210	55,361	111,040	30.2	434
Dec. 5	13,774	58,986	106,356	30.0	445
Dec. 12	20,544	64,277	90,237	30.2	437
Dec. 19	22,082	51,081	107,028	28.5	426
Dec. 26	21,026	51,426	94,623	29.4	406
1909					
Jan. 2	21,525	57,429	97,323	29.4	427
Jan. 9	18,954	69,009	93,593	31.4	471
Jan. 16	14,728	61,682	91,704	33.4	466
Jan. 23	13,712	67,759	97,562	33.9	502
Jan. 30	14,341	74,004	85,216	33.0	474
Feb. 6	12,734	66,610	97,577	31.1	456
Feb. 13	17,455	63,260	93,172	31.9	461
Feb. 20	17,115	62,192	96,880	32.1	470

When the refuse is particularly poor or contains an abnormal amount of moisture a small oil burner will furnish additional heat. The air supply to each grate is controlled by valves operated from the stoker platform. For operating the forced-draft fans, refuse transporter pumps, clinker crusher, screens and conveyors a 75-kw turbo-generator has been installed. A small portion of the steam from the boilers is used for operating the generator, leaving a large surplus available to sell for manufacturing purposes.

Table 2—Dead Animals Disposed of by Reduction During Three Years

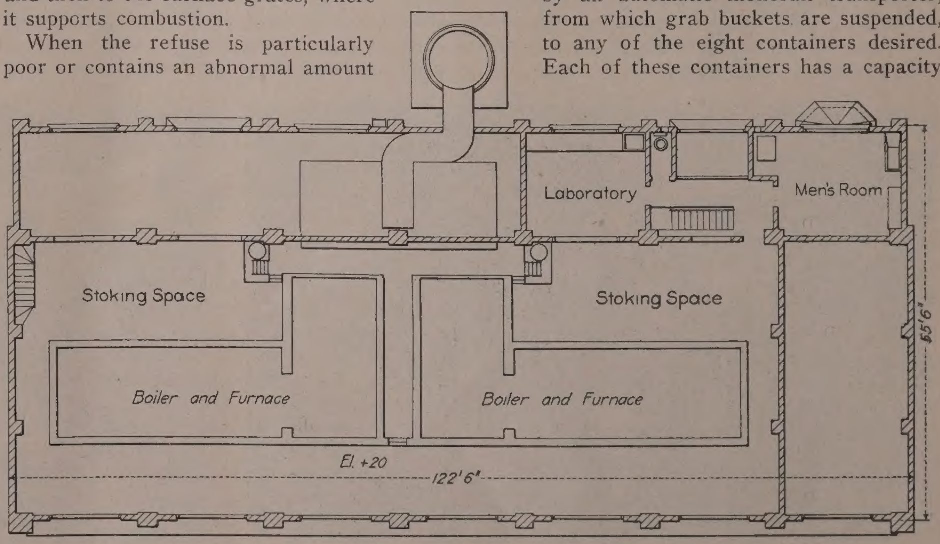
	1907	1908	1909
Horses	1800	1420	1469
Cows	120	100	113
Dogs	4200	3692	5447

An electrically driven pump discharges into an hydraulic accumulator. This supplies to the hydraulic machinery a pressure of 1500 lb. per square inch.

Table 3—Total Quantity of Refuse Collected in 1908, Estimated from Data Obtained from the Sanitary Reduction Works, and Showing the Probable Quantities of Ashes, Garbage, Rubbish and Manure Collected, as Computed from the Data Obtained by Investigation by the Board of Public Works

	Estimated average for the year in tons, per week day	Quantity of refuse collected in 1908 Tons	Cu. yd.
Ashes	43	13,600	24,000
Garbage	199	63,000	114,000
Rubbish	164	51,900	178,000
Manure	27	8,400	21,000
Total	433	136,900	337,000

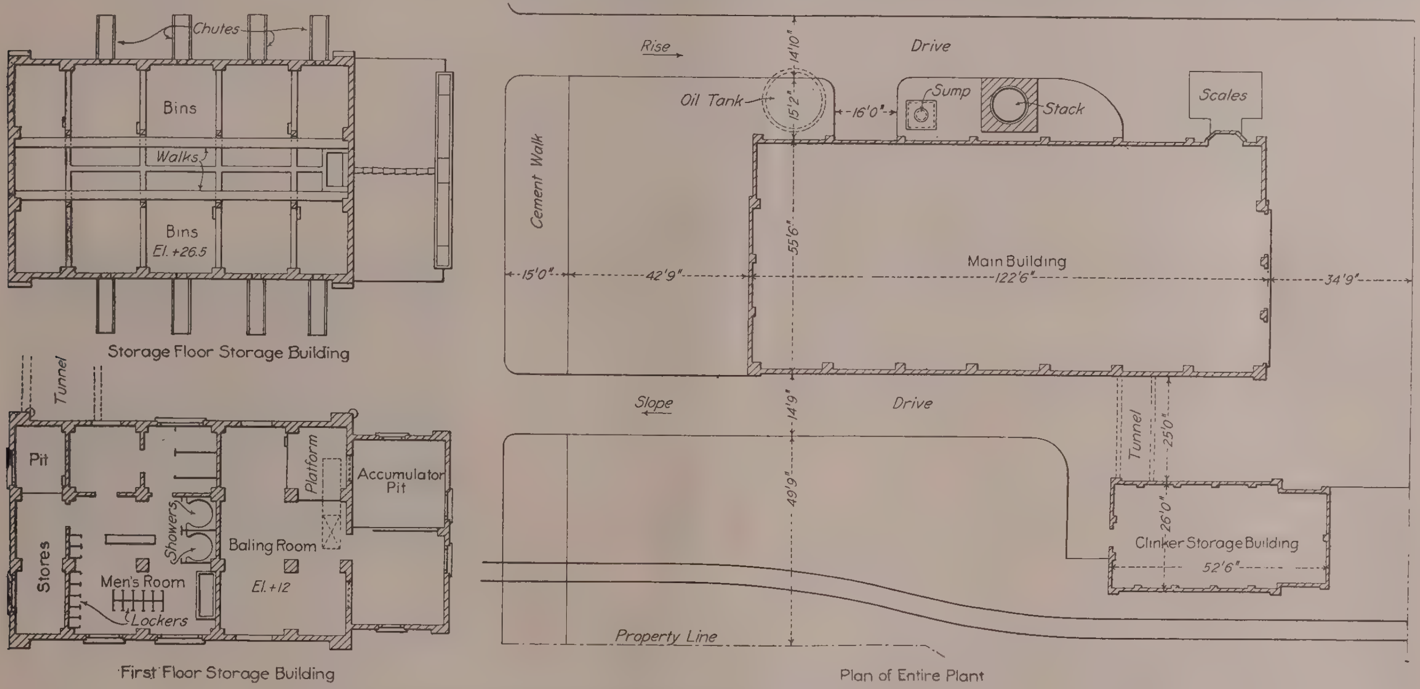
Refuse is dumped from the garbage wagons at street level into the storage pit, which has a capacity of 120 tons. Thence it is taken by an automatic monorail transporter, from which grab buckets are suspended, to any of the eight containers desired. Each of these containers has a capacity



Plan of Stoking Floor of the Islais Creek Incinerator of 1 cu. yd., a full charge for a single grate, and is directly above one of the furnace grates. The charges are fed to the grates by opening a sliding door in the bottom of the container. The lower side of this door is lined with fire-brick so that it may withstand the heat of the furnace, while the door is operated by hydraulic power and controlled by the stoker on the stoking platform. The charge can thus be fed to the grates at the exact moment desired.

When a sufficient number of charges have been burned on any one grate a heavy bed of clinker is formed. In the older plants it was customary to remove this clinker with hand tools. The task was very arduous and necessitated keeping the fire doors open for a considerable period, causing an inflow of cold air and a consequent cooling of the furnace. In this plant the entire grate is movable and the accumulation of clinker is ejected into a lower chamber by merely throwing a lever. The grate is slid from its position over the fire and tilted by hydraulic power, under lever control from the stoker platform.

In the lower chamber the clinker is partly cooled by contact with the air which is supplied to the furnace for combustion. By this means a considerable amount of heat is conserved. After cooling in the lower chamber the clinker is pushed by hydraulic power out of the furnace into a car, operated by a cable attached to an electric winch. It conveys the clinker from the furnace to the crusher, where it is dumped automatically.



Storage Floor Storage Building

First Floor Storage Building

Plan of Entire Plant

Two Floor Plans and General Layout of Islais Creek Incinerating Plant, San Francisco

TABLE 4—UNIT WEIGHT OF REFUSE, PERCENTAGES OF MOISTURE AND OF COMBUSTIBLE AND INCOMBUSTIBLE MATERIALS CONTAINED THEREIN AND ITS HEATING VALUE AS DETERMINED FROM DATA OBTAINED BY BOMB CALORIMETER

Date	Unit weight of refuse, in lb., per cu. ft.	Combustibles in refuse, percentage of weight	Incombustibles in refuse, percentage of weight	Moisture in refuse, percentage of weight	Heating value of the combustibles in refuse in B.t.u. per lb.	Heating value in refuse as collected in B.t.u. per lb.
1908						
Dec. 7	31.1	22.65	26.45	50.90	10,836	2,457
Dec. 10	29.5	22.46	25.37	25.17	10,540	2,352
Dec. 17	27.0	23.34	29.53	47.13	10,588	2,481
Dec. 29	29.6	23.06	27.71	49.27	10,330	2,388
1909						
Jan. 28	32.2	23.16	28.37	48.47	10,230	2,366
Average	29.7	22.9	27.2	49.9	10,530	2,410

The clinker is then crushed and is carried by a belt conveyor to the storage building, where it falls through sizing screens.

The incinerator was constructed under the direction of Mr. M. M. O'Shaughnessy, city engineer, and Mr. L. E. Hunt, chief assistant city engineer. Messrs. T. W. Ransom and Rudolph Hering are the consulting engineers, and Mr. H. A. Minton is the architect. Mr. K. Blue, assistant city engineer, made the studies of the garbage and prepared the specifications for the plant. The mechanical equipment was installed by the Destructor Company.

Protection of Croton Water

Eight recommendations for increasing the purity of water taken from the Croton watershed for use in New York City have been submitted to the Board of Estimate and Apportionment by Comptroller Prendergast of New York City. The first recommendation points out that railroads operating within the district are not provided with non-leakable sanitary equipment to prevent possible pollution of the water supply from the use of toilets on trains.

The second recommendation relates to increasing the efficiency in the use of hypochlorite of lime by mechanical agitation of the water instead of the gravity discharge now used. A sanitary patrol to constantly inspect the private sewage disposal systems is needed, according to the report, and aeration of the water should be adopted if the cost of installing plants for this purpose is not excessive.

Dredging, filling and draining swamps and low lands is also advocated. Grass, shrubbery and trees should be planted on exposed ground surfaces to prevent discoloration of the water by the erosive action of rains. The run-off from farm lands and roads might be cared for by dikes or drains and so improve the turbidity of the water.

Comptroller Prendergast further advocates the renovation of the Central Park reservoirs, stating the number of bacteria per cubic centimeter is excessive. A resolution has been presented to the governor by the Board of Estimate asking his assistance in securing action on the first recommendation.

Rapid Pump and Pipe-Line Installation at San Diego

In a recent emergency installation of a booster pump and 2 miles of pipe line to avert a water famine in San Diego the whole work was completed in seven days. San Diego and the surrounding territory supplied by the San Diego water department has a population of about 80,000, nearly double that of five years ago. Recently the growth of the city has been very rapid in anticipation of the opening of the Panama Canal, and the extensions have crept up the hills served by the high-service mains, obtaining water from the 21,000,000-gal. University Heights reservoir. Early in May it became apparent that a shortage of water might occur in the higher sections, and by the middle of the month the water in the city reservoir, which is fed by gravity from Chollas reservoir, 4½ miles away, by a 24-in. wood-stave pipe, dropped rapidly. There has been plenty of water in storage at the Morena reservoir and the upper and lower Otay reservoirs, but the pipe-line capacity under gravity flow is not sufficient to bring the water into town and hold up the level at University Heights, the normal difference in elevation being 53 ft., thus giving a hydraulic grade of 1 in 2000, which permitted about 7,200,000 gal. per day to pass, a quantity somewhat below the consumption.

A booster station, comprising a motor-driven centrifugal pump of 7,800,000 gal. daily capacity, had been in operation for three months at University Heights, but this station could not, of course, pump water that did not get to it. The problem was, therefore, to go back on the 24-in. line far enough to be sure that suction would not cause a vacuum on the line, resulting in collapse. The hydraulic engineer figured that going 12,000 ft. back from the University Heights reservoir would give sufficient static head to insure a pressure at all times on the pump suction. Another 200 ft. was added for safety, as it is of the utmost importance that nothing should happen to this one and only line into town. A 10-in. wrought-iron pipe was laid parallel with the wood stave, on Klauber Street in East San Diego, connecting it into the high-pressure distribu-

San Diego Booster Pump, Showing Various Specials in Connection

tion pipes leading from the University Heights reservoir. A plain booster layout would have necessitated a complete shutdown to permit of the installation of the valves and connections, and in addition there would be the danger of increasing the head during operation beyond that for which the pipe was originally banded.

It took exactly one week to get the machinery, install it, connect the suction with the 24-in. wood-stave pipe, lay 12,200 ft. of 10-in. wrought-iron pipe, lay 350 ft. of 12-in. cast-iron pipe, and connect it with a 30-in. main. The pipe for the work was ordered, hauled and laid within this period by six gangs of fifteen men each, working two shifts per day. A loan of 8000 ft. of wrought-iron pipe, intended for the exposition park for gas mains, was obtained from the San Diego Gas & Electric Company, 4175 ft. were purchased by wire and shipped from Los Angeles, and the remainder was on hand.

Saturday, May 17, a contract was closed with the owner of a 5-ton truck to haul the 150-hp motor and pump from a point 5 miles away, but owing to delay the water department took over the job and loaded the equipment on its 3-ton Packard truck and had it on the site of the suction connection Sunday. Unluckily, it was found that the electric company had no transformer on hand to step the 2200-volt current down to this 440-volt motor, so another trip was made and a 75-hp motor using current at 2200 volts was obtained. About 3000 ft. of transmission line were put in by the electric company while the pipe line was being laid.

A 6-in. belt-driven Krogh centrifugal pump was obtained from the Cuyamaca Water Company and set up over the wood-stave pipe on temporary timbers.

Connection to the wood pipe was made by a 10-in. saddle cast in a local foundry on the same day it was ordered and later placed. The specials used to reduce to the 6-in. pump suction and to increase again to the 10-in. wrought-iron pipe were made up of material on hand. The final joint to the 10-in. pipe, which had been laid previously, was made by slipping a piece of 12-in. cast-iron pipe over the outside of the 10-in. main and calking the space between the two.

In laying the line five arroyos, some of them quite steep, had to be crossed and the pipe was heated by fires and bent on the ground. At street crossings the line was depressed in the joints enough to lower it into a shallow trench with 6 to 8 in. of cover. Pipe tongs for the 10-in. size were not plentiful. Loans were made from the gas company and the Sweetwater Water Company. Twelve tongs were finally obtained. Some for 8-in. sizes had the chains lengthened and were used to assemble the pipes, leaving the final tightening for men with the larger tools.

Bend Made by Heating

Large Sleeve at Angle

Sharp bends were made by a number of short lengths of bell-and-spigot pipe. Where the sections being laid by the different gangs met 12-in. cast-iron pipes were used as sleeves. These acted also as expansion and contraction joints. In fact there was so much contraction when the water was turned in that one of the joints pulled apart about 2-in. and was repaired, without taking out all of the water, by using a 12-in. pipe as a sleeve. To put this on it was necessary to jack one section out of line. Kerosene was run in and as much lead poured as possible. Lead wool was then calked in on the lower side to effect absolute tightness. The starting of the pump was felt immediately; the consumers who had previously been without water and had complained bitterly obtained a sufficient supply for all practical purposes. Before starting the pump the pressure in the pipe line was 19½ lb. at the site of the pump and 11½ lb. at the far end. With the pump delivering about 1,300,000 gal. per day the outlet pressure due to the reservoir head was 10 lb., but at the pump it was raised to 49 lb. Following the installation the reservoir began to fill, showing gains of from 7,800,000 to 8,600,000 gal. per day.

Major Herbert R. Fay, member of the common council, is superintendent of the San Diego water department, and Mr. H. A. Whitney is hydraulic engineer and assistant superintendent.

Expansion Joint Made with Water in Pipe

Filtration Costs at Wilmington, Del., amounted to $1,821 per millon gallons during the year ended June 30, 1912, according to the report of Mr. John A. Kienle, at that time chief engineer of the water department. The water is taken from Brandywine Creek prefiltered through sponge clippings and passed through slow sand filters washed by a Blaisdell machine. With a population of 90,000 the per capita daily consumption was 124.7 gal. Preliminary filtration for 4,111,700,000 gal. cost $0.375 per millon gallons. Slow sand fitration for 4,012,800,000 gal. cost $0.916 per millon gallons, and laboratory charges were $0.530 per million gallons. These figures are gross operating costs and do not include interest and depreciation on plant investment. The slow sand filters were operated at an average rate of $5,400,000 gal. per acre. The hand rakings of the surface of the filter beds employed during the previous year with such good results were abandoned during the past year, and the beds were raked mechanically with the washing machine. At first, four ordinary farm cultivator teeth were attached, but later the regular machine teeth were used.

Small Granite-Block Pavement in Navy Yard at Brooklyn

Probably the first pavement to be laid in the United States similar to the Durax block pavement of England or the Kleinpflaster of Germany is being placed around Drydock 4 in the United States Navy Yard at Brooklyn. The building of this drydock, engineers will recall, was begun in 1905. After a great deal of trouble from the action of extremely treacherous quicksand and the failure of two contractors who attempted its construction it was finally completed in 1911 at an expense approximating $3,000,000. It is 700 ft. in length and 110 ft. wide. The new pavement covers an area of about 9000 sq. yd. and extends around the three land sides of the drydock in a strip 40 ft. in width.

A 6-in concrete base of 1:3:6 proportions was first carefully laid on a well-rolled foundation. A template was used to bring the concrete surface to the proper grade, an iron resembling an asphalt smoother being then applied to produce a surface finish similar to a well-troweled cement mortar.

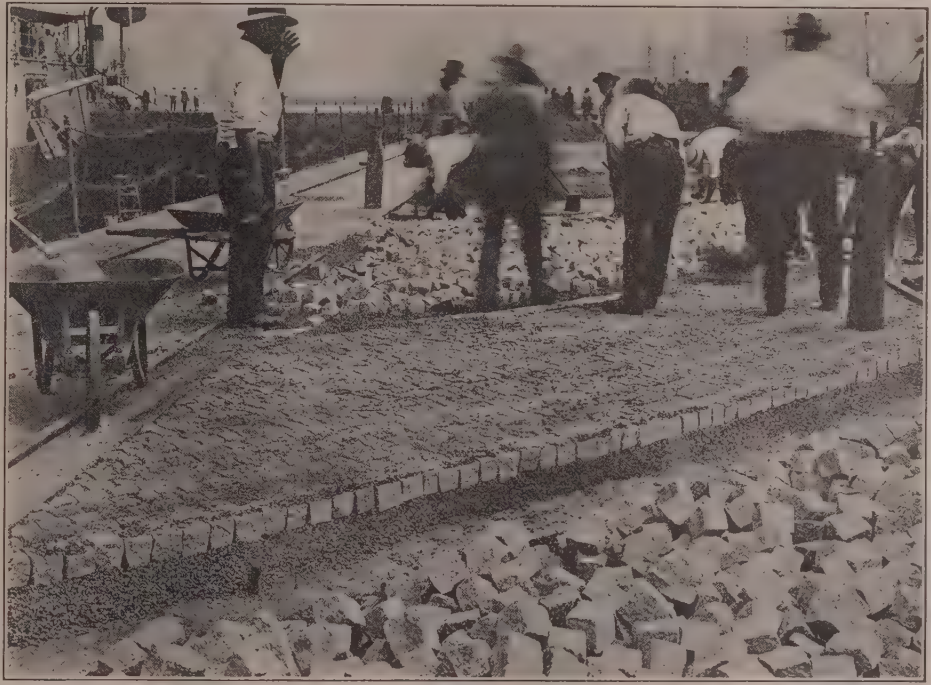
Laying Blocks

On this base is placed a ½-in. cushion of crushed-rock chips. The granite blocks are selected to fit, to some extent, the angles of the adjacent setts. Some difficulty was experienced in securing men capable of quickly laying a smooth and well-jointed pavement, but by selecting the more intelligent of the laborers and devoting some time to training them satisfactory work has been secured and a reasonable speed attained. Each man is provided with a bricklayer's hammer, which he uses to tap the blocks into proper alignment.

The construction of the navy yard pavement differs from the European practice in that, except for a small experimental portion, the blocks are being laid in straight lines or in arcs of circles of large radius instead of in concentric circles. This plan has been followed for two reasons. In the first place the European blocks generally come from the quarries in various sizes and the concentric-circle pattern readily lends itself to the use of the several shapes. The 2¾ x 3½-in. blocks secured for the navy yard pavement run so nearly uniform in size that little difficulty is experienced in matching them. The other reason is that the paving site is very much cut up with standard-gage railroad tracks and heavy crane tracks that parallel the basin on both sides. A great many manholes, flush-top conduits, and catch-basins also tend to make a straight-course pavement desirable. The advantage of distributing a wheel load over several blocks is obtained by laying the courses at a 45-deg. angle to the line of traffic.

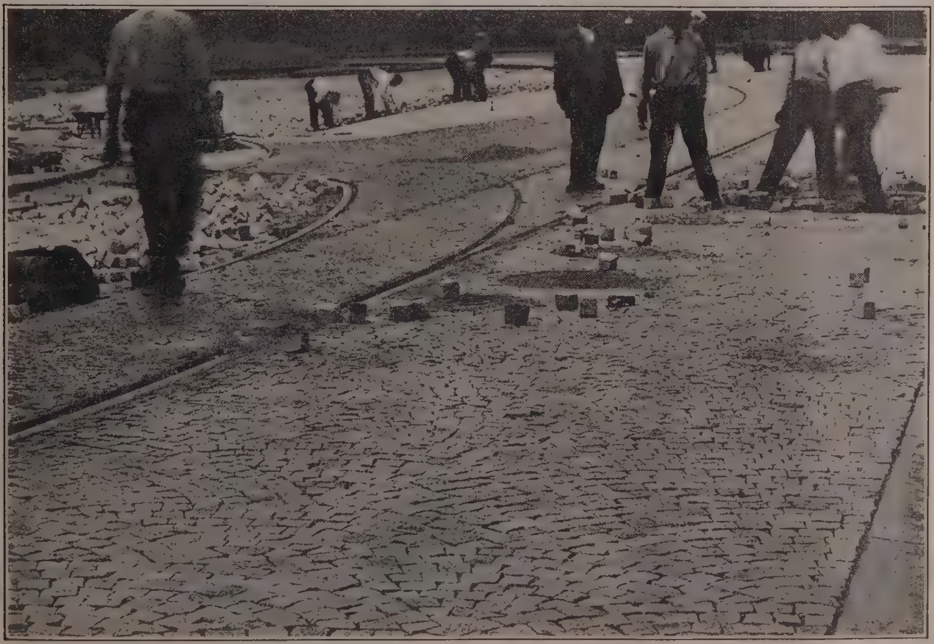
Filler

Crushed-rock chips, artificially dried, are swept, while they are yet hot, into the joints of the courses, after which a man follows promptly with a long ½-in. iron rod with which he tamps the wider joints and corrects any prominent irregularities which may appear in the surface of the pavement. A coal-tar pitch filler having a high melting point is heated to a temperature of 300 deg. Fahr., poured over the surface and broomed in. The grouting pitch is applied in quantities sufficient to penetrate the underlying cushion layer of chips and, it is thought, forms a waterproof surface. Sand is then spread as usual to absorb the surface coating of pitch.


Granite-Block Pavement with Cushion of Limestone Chips and Pitch Filler

Little or no crown is made to the pavement. Slight depressions are made about the catch-basins, the drainage being carried off through them in underground pipes to an outlet in the main sewers.

While traffic, in the sense of a procession of rapidly moving vehicles, cannot be said to exist at this point, a great deal of heavy trucking takes place around the drydock while vessels in the course of construction or repair are sheltered there. Large steel girders, heavy guns, armor plate, etc., that are being transferred to and from vessels are also allowed to stand for days at a time on the pavement. Hot coals are dumped on it at times from fireboxes. For these reasons wood-block pavement was impracticable and a comparatively smooth pavement was desirable. While the irregularities in the surface of any one block of the new pavement may be relatively large, they form, when closely laid, a comparatively smooth surface.


Experimental Section of Navy Yard Pavement Laid in Concentric Circles

Qualities of Pavements

Durax pavement is considered by foreign engineers to be durable, smooth, sanitary, and cheap. Its durability is derived from the wear-resisting qualities of the granite blocks; its smoothness from the small sized and close-fitting setts; its hygienic value is due to the non-absorbence of moisture, and its low cost is made possible by utilizing stone too small for other purposes and which are machine cut instead of being roughened out by hand.

The setts used in the navy yard pavement are secured in barge loads from the Harris Granite Quarries Company, of Salisbury, N. C., who imported a sett-making machine through the Wern Machinery & Engineering Company for this purpose. The machine is essentially a belt-driven, friction drop hammer, in which the monkey is attached to a lifting board and is fitted with a special form of hammer head. The stone is placed on the chisel-like anvil block, the fall of the hammer head being adjusted to any desired height by a foot lever. Two or three light, quick blows followed by a heavy one usually suffice to split the stone. The contract price of $4.10 per square yard exceeded the lowest bid for work under the customary granite specifications by 12 cents per square yard. This increased difference, some of those in charge of the work believe, will be offset as soon as granite-block manufacturers and contractors become familiar with the use of the new block. Others maintain, however, that the economy found by Europeans in the use of the small blocks will not be secured in America. Their theory is based on the difference in conditions; in England and on the Continent granite paving material is comparatively scarce and cost of labor is low while the inverse is true in this country. For this reason there is no economy in utilizing the small and irregular stones that are a part of the quarry waste to produce a paving material that is expensive to lay. As to whether the cost of the navy yard pavement is exceeding the contract price, as is rumored, the contractor will not say. The Uvalde Asphalt Paving Company, of New York, is the contractor and the work is being done under the supervision of Mr. Walter H. Allen, civil engineer for public works department of the navy yard.

Ties Bought and Treated in 1911

Co-operating with the Forest Service of the U. S. Department of Agriculture, the census bureau of the Department of Commerce has gathered statistics on the cross-ties purchased by the steam and electric railroads of the United States during 1911, and also of the number of ties treated with the various preservatives. Some of the figures are compared with similar figures for previous years.

Table 1 gives the number of ties purchased for each year from 1907 to 1911 inclusive, classified as to kinds of wood. Oak constitutes 44 per cent of the entire output for 1911; Douglas fir, cedar, Western pine and redwood meet the greater part of the demand in the far Western states. Chestnut is used extensively in the North Atlantic states, while oak, cedar, tamarack, hemlock, mixed hardwoods and Southern pine meet the requirements of the Northern states east of the Missouri River. The railroads in this region have been forced to draw upon many species and a wide area to meet their increasing cross-tie requirements. Southern pine, cypress, oak and gum fill the wants of the railroads of the Southern states. Local woods are always used if they possess durability and hardness.

No reports were obtained upon the average cost of ties. In 1909 the average cost was 49 cents, the prices by kinds of wood ranging from 33 cents for hemlock to 53 cents for redwood and for Western pine. It is stated that as a whole prices have not changed considerably since that time, although there have been fluctuations in many tie-producing localities.

The steam railroads purchased 93 per cent of the total number of ties in 1911, which is somewhat smaller than the proportion reported in 1910. The purchases of the electric railroads have shown a regular, though slow, increase in recent years, reflecting the steady development of these lines, while the purchases by the steam railroads have fluctuated considerably according to industrial conditions.

Preservation

In 1911 more than 73,000,000 gal. of creosote oil and more than 16,000,000 lb. of zinc chloride were used by the wood-preserving plants of the United States, and cross-ties formed 74 per cent of all material treated. Table 2 gives the number of ties treated in each of the years from 1907 to 1911. The bulk of these ties was for steam roads, but the electric railroads show a steady increase from 619,000 in 1908 to 1,382,000 in 1912.

Table 1—Cross-Ties Purchased, by Kinds of Wood from 1907 to 1911

Kind of Wood	1911	1910	1909	1908	1907
All kinds	135,053,000	148,231,000	123,751,000	112,466,000	153,703,000
Oak	59,508.000	68,382,000	57,132,000	48,110,000	61,757,000
Southern pine	24,265,000	26,264,000	21,385,000	21,530,000	34,215,000
Douglas fir	11,253,000	11,629,000	9,067,000	7,988,000	14,525,000
Cedar	8,015,000	7,305,000	6,777,000	8,172,000	8,954,000
Chestnut	7,542,000	7,760,000	6,629,000	8,074,000	7,851,000
Cypress	5,857,000	5,396,000	4,589,000	3,457,000	6,780,000
Tamarack	4,138,000	5,163,000	3,311,000	4,025,000	4,562,000
Hemlock	3,686,000	3,468,000	2,642,000	3,120,000	2,367,000
Western pine	2,696,000	4,612,000	6,797,000	3,093,000	5,019,000
Redwood	1,820,000	2,165,000	2,088,000	871,000	2,032,000
Gum	1,293,000	1,621,000	378,000	262,000	15,000
Maple	1,189,000	773,000	158,000	151,000	....
Beech	1,109,000	798,000	195,000	192,000	52,000
All other	2,682,000	2,895,000	2,603,000	3,421,000	5,574,000

Table 2—Cross-Ties Treated from 1907 to 1911

1911	31,141,000
1910	30,544,000
1909	22,033,000
1908	23,776,000
1907	19,856,000

Table 3 gives the number of ties treated in 1911 by all railroads, classified as to kind of wood and preservative, including creosote, zinc chloride and creosote and zinc.

Table 3—Number of Cross-Ties Treated, by Kinds of Wood and by Kinds of Preservative, in 1911

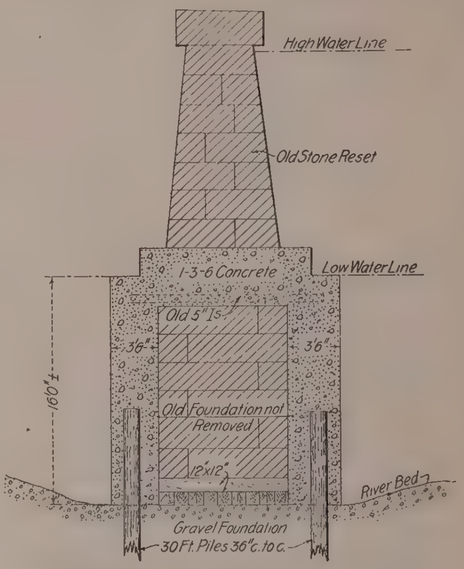
		Kind of Preservative			
Kind of wood	Aggregate	Creosote	Zinc chloride	Creosote and zinc chloride	Miscellaneous
All kinds	31,141,231	17,636,735	8,670,929	3,015,075	1,818,492
Southern pine	11,606,392	9,380,540	1,108,660	258,431	858,761
Oak	9,433,002	5,305,493	2,267,641	1,496,103	363,765
Douglas fir	3,628,706	28,903	3,515,119	....	84,684
Western pine	1,789,026	663,519	669,892	....	455,615
Gum	1,182,095	958,684	214,178	....	9,233
Tamarack	755,414	155,819	248,117	312,544	38,934
Beech	730,328	325,868	329,216	74,344	900
Birch and maple	620,047	395,357	101,068	123,122	500
Hemlock	535,255	7,936	....	527,319	....
Elm	292,008	145,670	47,015	98,423	900
Spruce	102,808	83,630	14,178	....	5,000
Cypress	101,864	4,100	....	97,764	....
Lodgepole pine	92,158	....	92,158	....	....
White pine	78,273	78,273	....	....	....
Hackberry	62,568	5,700	31,843	25,025	....
Chestnut	47,538	47,338	....	....	200
Sycamore	32,244	400	31,844	....	....
Cedar	26,000	26,000	....	....	....
Hickory	21,441	21,441	....	....	....
Walnut	2,000	....	....	2,000	....
Ash	1,390	1,390	....	....	....
Cherry	674	674	....	....	....

Reinforcing a Scoured Pier Foundation

By Edward Stingel, County Engineer, New Philadelphia, Ohio

Tuscarawas County, Ohio, like other river counties in the state, lost its quota of bridges during the recent March flood. All failures, except one, were caused by faulty foundations. The first repair work to be completed is the rebuilding of a stone pier in 16 ft. of water in the Tuscarawas River at Newcomerstown, which was built in 1896. The foundation, consisting of two thicknesses of 12 x 12-in. timbers, was built on the river bed. The stones were laid in natural cement mortar. The pier which failed settled 24 in. at the upstream end, tilting the pier without breaking a stone or opening a mortar joint.

A diver was employed to inspect the condition of the foundation and the river bed immediately around the pier. He reported that the pier had a uniform bearing on the river bed of coarse gravel.



Old Foundation Inclosed by New One

Instead of removing the entire pier and rebuilding it in the usual way, the pier was removed to a plane 24 in. below low water line. Piles were then driven to refusal 3 ft. on centers around the old foundation, which was not removed. These piles support a new foundation built around and over the old one, as shown in the accompanying drawing. No cofferdam was built, as no excavating was done. A tight foundation form properly braced retained the concrete which was deposited under water. The old stones were reset on the new foundation.

This method of repair was a speedy and economical one, and it is believed to be justifiable in this particular case. The contract cost was $9 per cubic yard for the concrete, including all forms and removal of the old pier above low-water line. The price for the piling in place was 50 cents per linear foot.

The Fourth Town-Planning Unit in the development schemes of the city of Birmingham, England, is shortly to be presented to the British Local Government Board for approval. The new plan is reported in the "Consular and Trade Reports" as embracing a tract of 8000 acres that is now ripe for improvement. With the three units previously approved Birmingham will have 14,000 acres under development along scientific town-planning lines.

Replacing Cedar River Bridge

Building New and Extending Old Piers—Erecting Plate-Girder Spans by Derrick Cars and by Overhead Jigger Beams

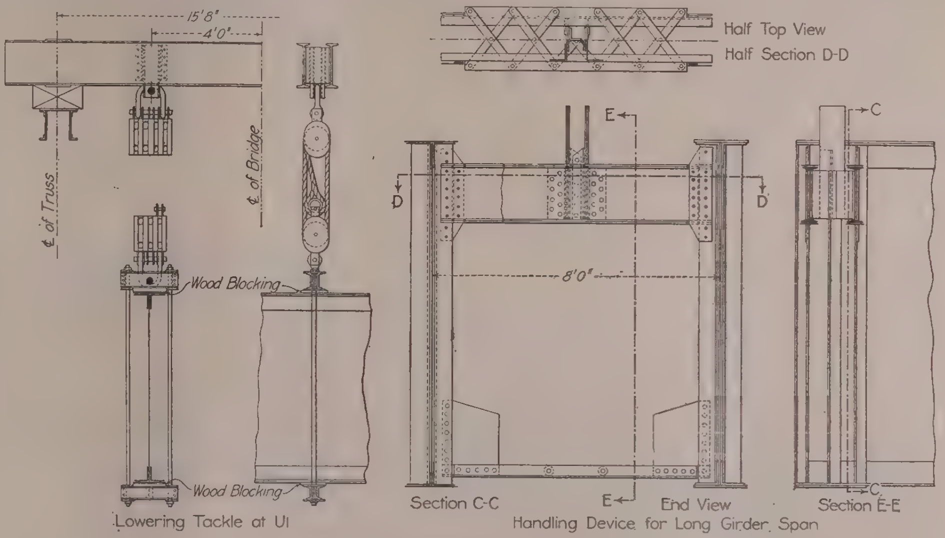
Until recently the Iowa division of the Chicago, Rock Island & Pacific Railway crossed the Cedar River ½ mile west of Moscow, Iowa, on a single-track through-truss bridge. The bridge, which was built in 1892, was about 794 ft. long between back walls; it had five double intersection riveted Warren girder spans, from about 150 to 175 ft. long, supported on masonry piers. The loading and traffic having increased beyond the capacity of the superstructure, it was decided to replace the latter by new double-track spans to accommodate the service, which for several years had been double track on this part of the line, except for the river crossing.

The old masonry piers, about 25 to 30 ft. high above their pile foundations, were in good condition; and as the water is shallow and as there is a good bottom of coarse sand and gravel overlying hard blue clay from 40 to 46 ft. below the old base of rail it was determined to extend some of the old piers downstream, build up the top with reinforced concrete and retain them in the new structures. At the west end of the bridge reinforced-concrete piers and pile foundations were built midway between the old piers, which were retained, and with the latter carry a superstructure consisting of two lines of single-track plate girder spans 75 ft. and 77 ft. 9 in. long over all. One line is concentric with the former bridge and the other line is 13 ft. farther downstream, in a position clearing the old trusses.

The bridge was lengthened 72 ft. 3⅛ in. at the east end, where a 90-ft. span was added, which, together with the adjacent 77 ft. 9-in. spans, was carried entirely on new piers and an abutment clearing the old piers and abutment, which were abandoned and removed because their locations did not conform to economical span lengths. This arrangement of one new abutment and seven new piers and one old abutment and three old piers remodeled supports eleven pairs of new single-track spans. The grade of the track was raised 6 ft. on the new structure.

Remodeling Old Substructure

The ends of the old trusses were jacked up clear of the masonry and the tops of the three old piers at the west end of the bridge were removed down to the third joint below the bridge seat, and the old stones in the downstream end of the pier were removed, leaving a racked surface to engage with the extension. Thirteen new piles were driven and cut off to support a 10 x 11½-ft. footing, 4 ft. thick, reinforced by horizontal bars just above the tops of the piles, which penetrated it 18 in. On this footing new stone masonry was built and bonded into the old masonry extending the pier 7 ft. 4 in., and on it and on the old masonry there were built an upper course of concrete and a concrete coping, together 37 in. thick, reinforced near the upper and lower surfaces.



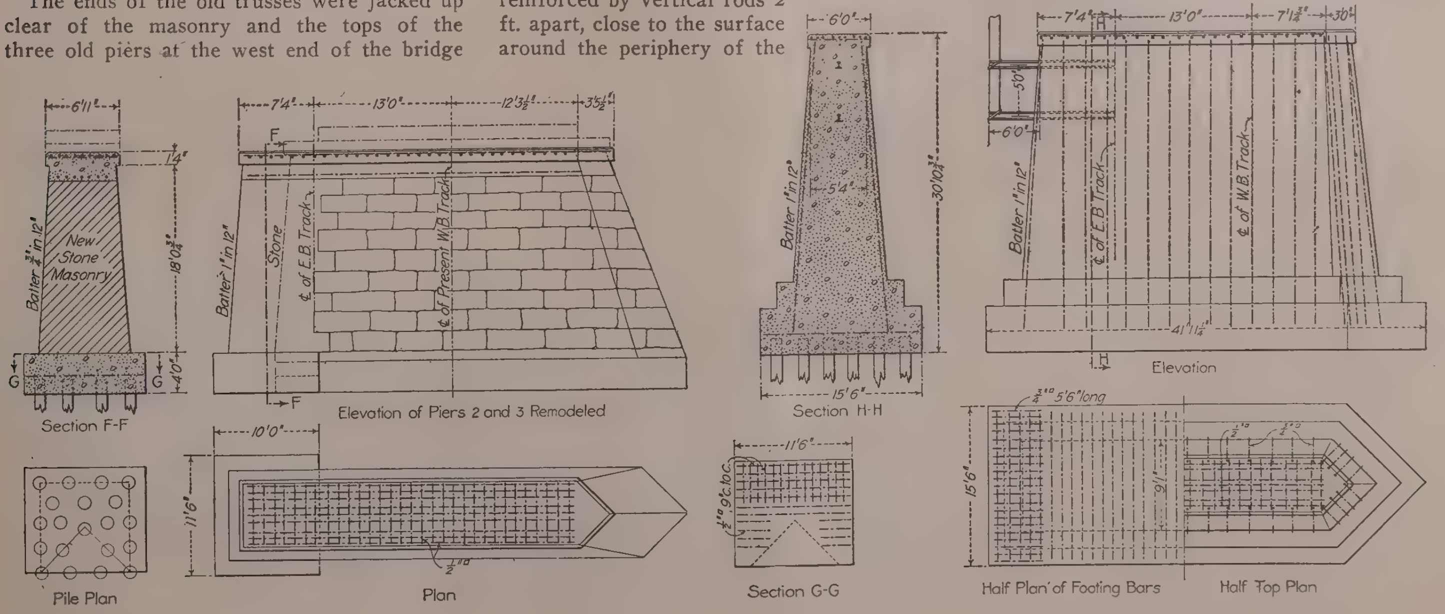
Special Appliances for Lifting Single Heavy Girders and Complete Spans

The west abutment was remodeled in a similar manner, except that the extension included a wing wall oblique to the bridge axis and a comparatively thin back wall about 12 ft. high, and that the new work was entirely of concrete.

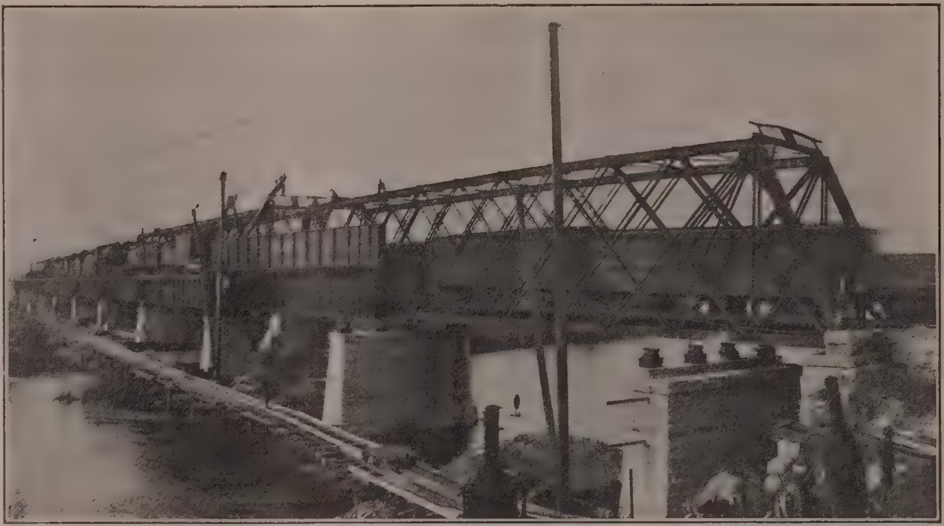
All of the new piers were substantially like the one shown except for slight variations in height of pier and size of footings. Their design was special in that they were reinforced by vertical rods 2 ft. apart, close to the surface around the periphery of the shaft, and that there were embedded in each pier two 13-ft. lengths of 80-lb. horizontal T-rails 5 ft. apart in a vertical plane, which projected about 6 ft. beyond the downstream end of the pier to form cantilever arms supporting telegraph poles outside the train clearance. The piers were made of 1:3:5 concrete, with 1:2:4 coping, and were reinforced with deformed bars bound together at intersections with No. 16 wire. The amount of concrete in each pier varied from 314 to 358 cu. yd. In the largest pier the area of the footing was 652 sq. ft. and the weight of the reinforcement steel was 4050 lb. There were 84 foundation piles, with an average load of 17.5 tons each.

The east abutment and its two slightly oblique wing walls have a concrete footing 6 ft. deep and about 80 ft. long and 25 ft. wide. The east abutment has a battered face and offset back reinforced only at the bridge seat. It contains 1005 yd. of concrete and has 164 foundation piles, sustaining a load of 15 tons each. All of the footings are from 7 to 15 ft. below the bottom of the river and are carried into the blue clay stratum.

The new foundations and the extensions of the old ones were built in open cofferdams and the stone and concrete were delivered to them on a low-level service track clearing the new work on the downstream side of the



Masonry Extensions with Reinforced-Concrete Tops and Footings and Pile Foundations for Old Piers



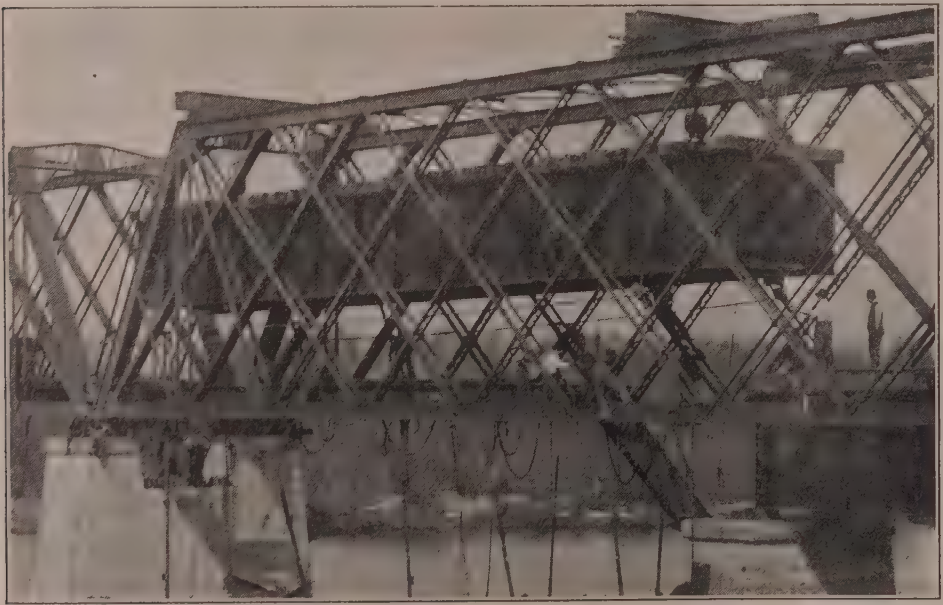
Erecting First Line of New Deck Spans on Pier Extensions

bridge. Guy derricks were installed to command the piers, and the 4500 yd. of concrete were mixed on shore at the west end of the bridge.

Erection of New Downstream Spans

One-half of the superstructure, consisting of a complete set of single-track spans on the downstream ends of the piers, was erected and put into service without interfering with traffic while the old superstructure was retained in use, being operated with a gauntlet track. Before the erection was commenced the old trusses were moved 3 ft. upstream to allow room on the approaches for a 6-ft. fill required by the change of grade before mentioned.

The girders were delivered at the west end of the bridge. All of the 75 ft. and 77 ft. 9-in. spans were erected in the usual manner by a derrick car having a boom long enough to place the girders for the span in advance when the car was seated on the last completed span. The girder shoes, pedestals and grillages were temporarily placed on the tops of the piers 3 ft. downstream from their final positions, in order to provide a distance of 18 ft. between track centers and allow for the fill in the approach grade without interrupting traffic.



Photograph Copyrighted by J. G. Baker, Columbus Junction, Iowa

Erecting Second Line of Plate-Girder Spans from Jigger Beams

The 90-ft. girders were much heavier than the others and were delivered on flat cars on the traffic track, pushed through the bridge from the west to the east end and there unloaded by a wrecking car on the traffic truck on shore at the east end and by the derrick car on the bridge at the west end. These cars placed the girders temporarily on falsework and cribbing provided to receive them before the completion of the east abutment. Afterward the girders were again lifted and set on their bearings, in temporary position, on the substructure.

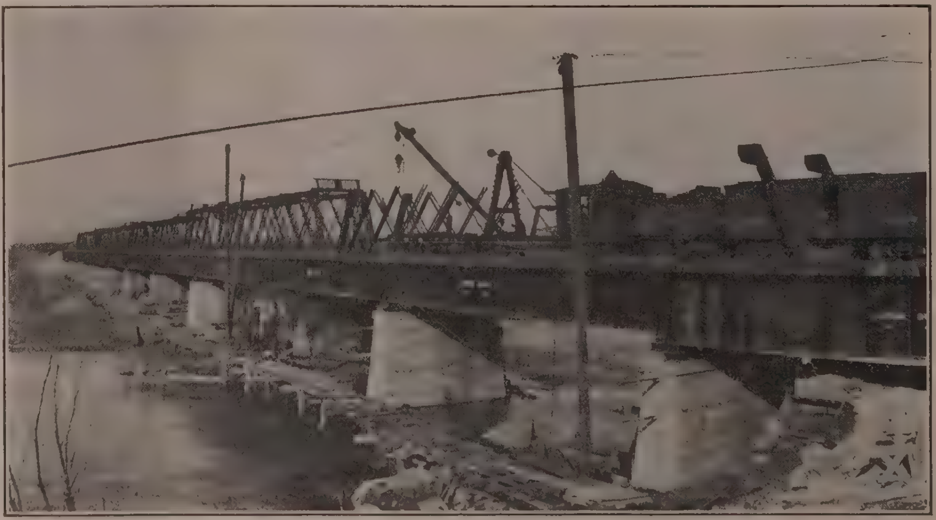
As fast as each span was erected the bracing was assembled and riveted and when completed a gauntlet track was laid on them, connected to the main line and traffic diverted to it, thus releasing the old spans.

At the east end of the old bridge as many rivets as could be spared from the old floor system were cut out in advance, while the girders for each span in the upstream or westbound track were riveted together complete in the yard near the end of the bridge. The completed spans, loaded on two flat cars each, were delivered between the old trusses to the required position and lifted clear of the trusses by tackles suspended from transverse jigger beams resting on the top chords of the old trusses and operated by a locomotive, which, after pushing the girders to position, was attached to the lead lines and slowly backed away. After the cars were thus released they were pushed away and the girders remained suspended, the tackles remaining commanded by the locomotive while the floor system was rapidly removed, allowing the girders to be lowered to supports on their shoes and pedestals. The track was immediately laid on the span, another span erected in the same way, and so on. The illustration of the span suspended from the jigger beams shows the removal of one of the old floorbeams and gives an excellent idea of the operations, although it is made from a photograph of a similar bridge renewal on the same line at Columbus Junction, Iowa, which was effected by the same apparatus and in the same manner.

Jigger Beams and Lifting Connections

The jigger beams used for unloading the upstream spans were made of pairs of 20-in. I-beams riveted together 20 in. apart on centers with top and bottom flange tie plates and lattice bars. About 4 ft. each side of the center the webs were connected by pairs of vertical transverse diaphragms 8 in. apart, to which were riveted pairs of vertical channels projecting below the lower flanges and bored for transverse pins, to which the hoisting tackles were shackled.

In some cases the blocks of the shackles were secured to yokes engaging the single

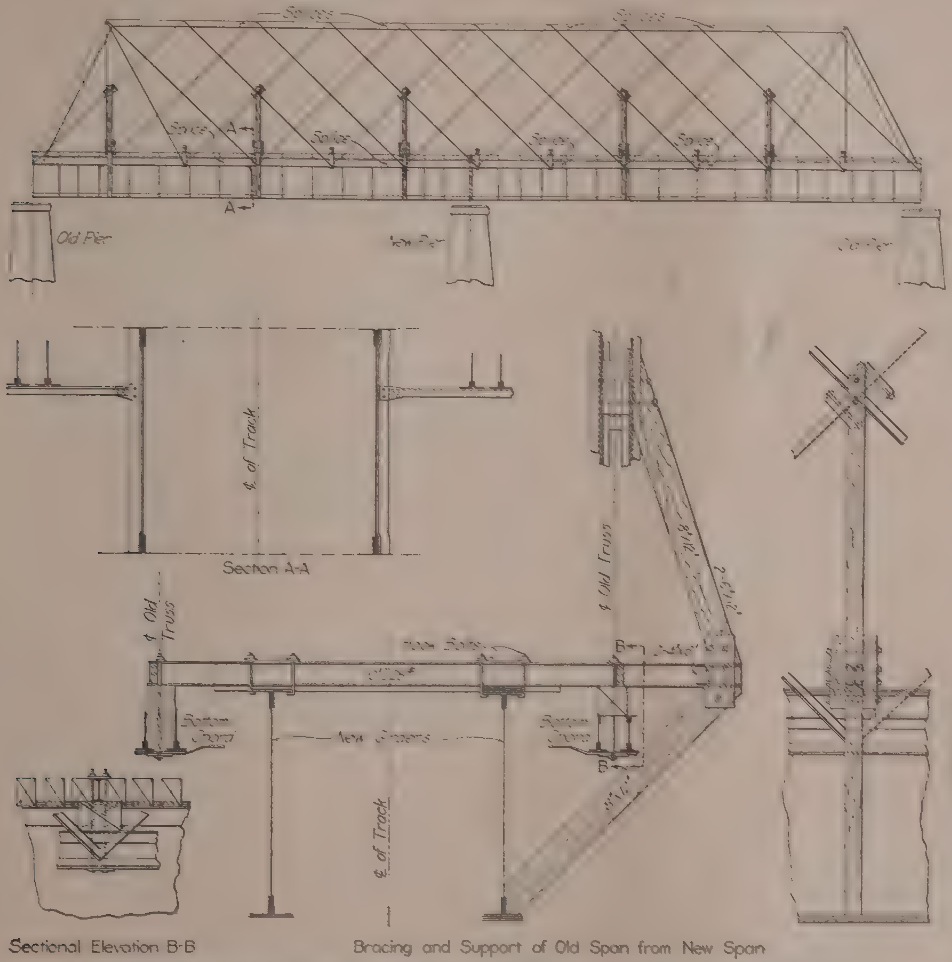


Old Spans Supported on New Spans and Removed by Derrick Car girders. Each yoke had duplicate top and bottom beams, made of pairs of channels riveted together back to back, with clearance between them for screw-end vertical rods.

In some cases the yokes were dispensed with and the lower tackle blocks were shackled to connections projecting above the top flanges of short plate girders bolted to the vertical web stiffener angles at the ends of the main girders of the span.

REMOVING OLD SPANS

After the upstream plate-girder spans were erected the old trusses were supported from them and removed by the derrick car. Transverse 10-in. I-beams, 24½ ft. long, were set on the top flanges of the girders between the track ties at panel points of the old trusses, and were securely clamped to the girders by hook bolts engaging the top flanges of the latter. Pairs of vertical suspension bolts, engaging saddle plates under the bottom flanges of the old bottom chords, took bearing on saddle plates, supported on the top flanges of the I-beams, and were screwed up to transfer the weight of the old trusses to the cantilever ends of the I-beams, thus giving the members of the old trusses stability independent of the integrity of the trusses, which could then be destroyed by the removal of successive members.



Sectional Elevation B-B

Bracing and Support of Old Span from New Span

Method of Supporting Old Trusses on New Deck Spans and Details of Bracing

The cantilever ends of the I-beams projected beyond the old trusses to give lateral stability to the extremities of inclined wooden braces bolted to them and engaging the bottom flanges of the girders and the web members of the trusses about half way between the top and bottom chords so as to maintain the trusses in vertical position after the top lateral system was removed. Horizontal transverse struts were also connected to the bottom flanges of the lower chords and to the vertical web stiffeners of the girders, to give the former additional lateral stability. Beginning at the east end of the bridge the derrick car removed all of the steelwork of the old superstructure as the members were disconnected, taking down the top lateral system, top chords, web members and bottom chords successively.

The work above described was executed under the direction of Messrs. J. B. Perry and I. L. Simmons, respectively chief engineer and bridge engineer of the Rock Island Lines. The substructure work was done by the Cedar Rapids Construction Company. The 1015 tons of structural steel were fabricated by the American Bridge Company. It was erected and the 700 tons of old steel were removed by the company's forces in charge of Mr. C. E. Ziegenbein.

THE RECOVERY OF METAL SCRAPS, exclusive of iron, aluminum and precious metals, amounted in 1912 to $77,395,000, according to figures recently published by the U. S. Geological Survey. The metals included in the commutations are copper, glass, lead, zinc, tin and antimony, the recovery of which has become a large industry, highly developed, in order to secure a proper market for its output. Brass in a great variety of compositions heads the list in both tonnage and value, amounting to $27,279,000, while copper (exclusive of that in brass) totals $21,593,000. Tin was third on the list in value, followed by zinc and lead. The value of the lead recovered was somewhat more than $6,000,000, while the antimony is at the bottom of the list with a value of $426,000.

Creosoted Wood Blocks for Factory and Warehouse Floors

By F. A. Weaver, of the Cleveland Office of the Ayer & Lord Tie Company, Chicago

There have been many million feet of lumber wasted for pavements and floors, and it has been largely on account of either the lack of knowledge of wood preservatives or a desire on the part of those designing to construct cheap work. In order to get the best results with wood blocks and extend their mechanical life, it is necessary to select a wood which is naturally strong, straight of grain, and able to resist abrasion.

Yellow pine has proved more serviceable and satisfactory than any other wood used, because it has the natural qualities which seem to meet the service required in either street or factory paving—those of toughness, strength and hardness, combined with a straight grain and long fiber, which carry the load uniformly through to the foundation. The end grain has a resistance to indentation and is practically non-abrasive. It is also easier to secure yellow pine than most other wood free from dead timber and shake, or other defects of lumber. Yellow pine takes the preservative readily, and when properly handled will not shrink or buckle in the pavement.

Experiments and tests have been made with many chemical compounds as preservatives, but none has been so effective as creosote. The treatment of the block with different oils depends altogether on the service to which the floor will be subjected. Blocks for a factory floor which is dry should be treated with an oil of lower specific gravity than those intended for a wet or damp floor; but, in no case should an oil be used which is heavy enough to bleed, forming on the pavement a tar surface which is most disagreeable on account of tracking and the high resistance to traction. Blocks treated for street use should not be used for a dry factory floor.

CONSTRUCTION

Proper construction of a wood-block pavement for floors requires that all service pipes be placed at least 6 in. below the ground line. The ground should be thoroughly compacted before any attempt is made to lay the concrete, the thickness of which should vary from 4 to 6 in., depending upon the character of the soil and the loads to which the floor will be subjected. This should be brought to an even surface so that a uniform depth of ½ in. of coarse sand can be spread as a cushion for the blocks. Where there is to be considerable heavy trucking the blocks should be held rigidly in place; a mixture of 1 part of Portland cement to 3 parts of sharp sand mixed dry should be spread on the concrete base to a depth of ½ in. and thoroughly wet as the blocks are laid and immediately tamped. Another method is to construct an even surface with a mixture of 1 part of cement to 2 or 3 parts of sand, and after this has become hard apply a mop coat of hot tar and lay the blocks in this coating on the smooth concrete. Still another plan is to dip each block in hot tar to half its depth and lay it on a smooth surface as above described. This makes a firm bond, and while this is an expensive method of laying it gives excellent results for floors on which heavy castings or bodies are rolled and where the temperature is usually high.

A thoroughly waterproof surface can be obtained by laying as above described and then flowing the surface with hot tar or asphalt, and scraping the surplus material from the top of the pavement. This makes good construction for wash-house floors in breweries, garages or barns. In the construction of a waterproof floor, however, much care must be taken in the selection of the blocks; it is desirable that they should not be cut from too dry material, and a 12 to 16-lb. treament with oil of a specific gravity from 1.08 to 1.12 is recommended.

FILLER

Another matter of great importance is the selection of tar or asphalt for use as a filler or expansion joint. Wood blocks act contrary to brick, in that they expand in wet and cold weather, whereas brick contracts, so that the filler should be bituminous with a melting point of 125 to 135 deg.—preferably 130 deg. —determined by the cube method of testing. A pitch filler with a melting point of 145 to 155 deg. is successfully used for street paving, but for factory work a more pliable material must be used. Ordinarily for machine shops and dry floors blocks cut from air-dried stock should be used, thoroughly treated with an oil of specific gravity of 1.05 to 1.09 to the extent of 8 lb. per cubic foot. It is essential, however, that in using a light treatment an approved empty-cell process should be used so as to insure a perfect penetration, as blocks treated with so small a quantity of oil as 8 lb. under the full-cell process are not perfectly penetrated. The Rueping process has been successfully used to attain this end.

The blocks should be laid in close parallel courses at right angles with the length of the building, and about every sixth course should be driven up. The advantage in so laying them is that in case of shrinkage the blocks can be pinched up, which is not possible where they are not laid in parallel courses. A ⅞-in. strip for expansion should be placed along each wall, the blocks being laid up to this. All high or low places should be leveled up and the entire pavement gone over with a roller not heavier than 5 tons, or tamped under a board so as to assure an even surface. After the pavement has been tamped or rolled the strips for expansion joints should be removed carefully and the spaces filled with expansion material to within ½ in. of the surface of the floor. The surface of the pavement should be covered with fine dry sand, which should be allowed to work into the interstices.

DEPTH

The depth of the blocks depends largely upon the service required. Anything less than 3 in. is not entirely satisfactory on account of breakage of the blocks before and after they are in place. Some engineers have gone to the other extreme and recommended a 4-in. block where a 3½-in. or even a 3-in. block would be ample.

The success of the wood-block floor depends upon the quality of the timber, the treatment of the block and upon construction adapted to the particular conditions of the factory. Where wood blocks have failed it is generally due to errors under one of these heads.

Where an industrial track is run through a building blocks are usually cut to fit under the head of the rail, although another method used is to cement up the rail and lay the blocks flush with the cement. It is also the practice in some plants to fill under the head of the rail with creosoted wood strips and lay the blocks flush against the rail.

ADVANTAGES

Blocks can be readily taken up and replaced where a service cut is made. Broken blocks can be easily removed and replaced without disturbing the adjoining blocks. There is no breakage of tools or parts handled in manufacture as on a hard floor. Greater efficiency is obtained from workmen, as the surface is not hard, and the blocks are resilient. Workshop noises do not reverberate as from a monolithic floor. There is no dust from the blocks to work into machine bearings, or for men to breathe, while, on the other hand the creosote is a disinfectant and acts like floor oil to keep down dust. A block pavement withstands the heaviest trucking or the handling of heavy materials and allows easy traction. There is no maintenance cost, the first cost being its only one. Taken as a whole, therefore, creosoted-wood blocks make a durable and satisfactory floor for industrial plants, warehouses and freight depots.

New Type of Pelton-Wheel Governor

A new governor for waterwheels of the Pelton type has recently been put on the market by A-G der Maschinenfabrik von Theodor Bell & Company in Switzerland. Its main object is to prevent water hammer in the penstock by retarding the needle in closing, but at the same time to cut off the water from the wheel immediately. This is done in the manner illustrated in Fig. 1.

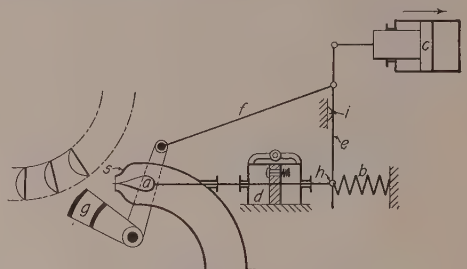


Fig. 1—Elements of Governor

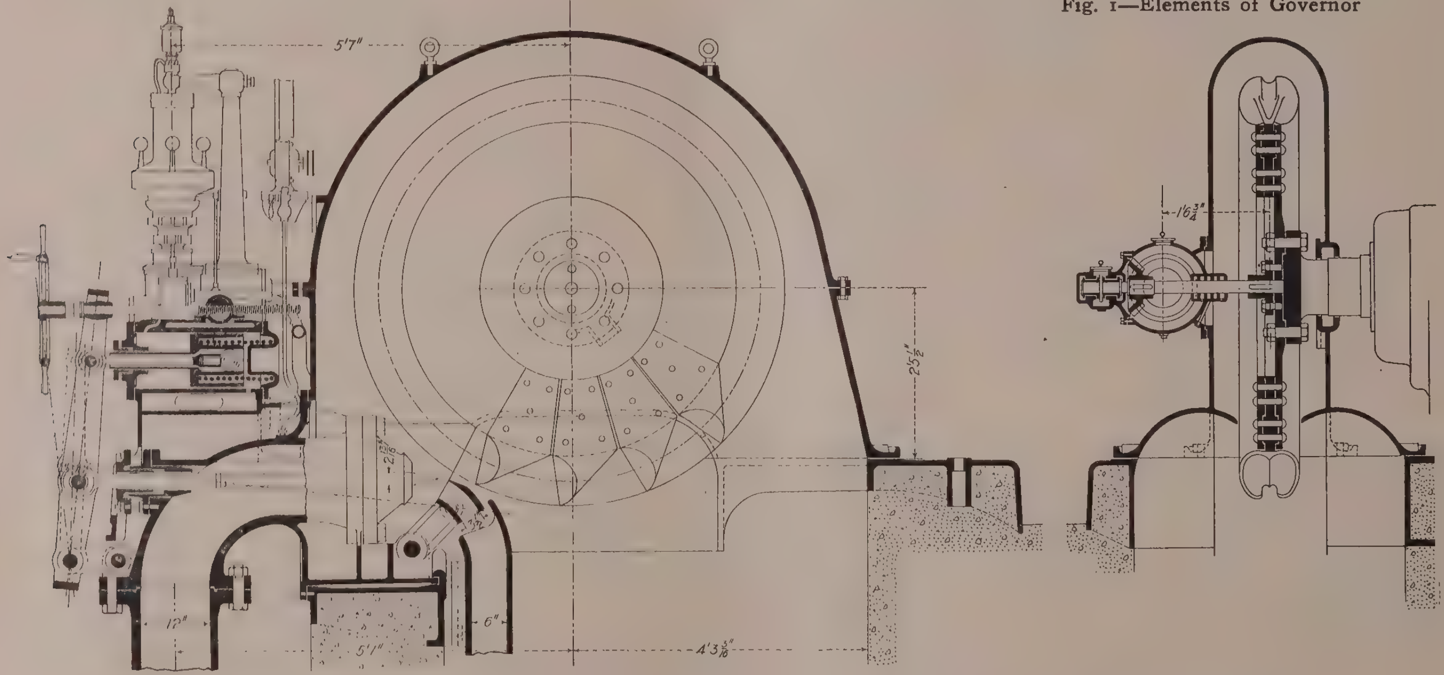


Fig. 2—Longitudinal and Transverse Sections of Pelton Waterwheel, with New Governor, Installed in Swiss Plant

The needle *a* always tends to close the nozzle *s* because of the pressure of the spring *b*. This closing is prevented by pressure on the piston *c*. If this piston is moved quickly so as to close the nozzle, i.e., in the direction of the arrow, the quick movement of the needle will be prevented by the oil dashpot *d*. It is to be noted that the rod *e* connecting the upper cylinder with the needle is deflected around the point *h* and pulled away from its support *i*, whereby the rod *f* pulls the jet deflector *g* up to the nozzle *s*. As the spring *b*, retarded by the dashpot *d*, slowly moves the needle *a* until the nozzle is closed, the rod *e* will at the end of the motion be again resting on its support *i*.

This design has been used at the Arniberg der Amsteg development in Switzerland in the form shown in Fig. 2. It will be noted that a hand-closing device for the needle has also been incorporated in the design for this unit.

* * *

A DRYDOCK, 60 x 1200 ft. in plan and 65 ft. deep, is to be built by the Dominion of Canada at St. Joseph de Levis, opposite the city of Quebec. The site that has been selected is solid rock and will require a great deal of blasting.

Organization of an Engineering Construction Company

At a recent meeting of the Boston section of the American Institute of Electrical Engineers, Mr. Roy M. Henderson, assistant construction manager of the Stone & Webster Engineering Corporation, presented a paper describing the organization of that corporation and the interrelationship of the various departments that conceive, construct and operate vast engineering projects.

Organizations of this type have developed, in Mr. Henderson's judgment, because of the centralizing tendencies of the industrial world, the increasing size of engineering and construction undertakings and the advantages due to placing large and complex projects in the hands of a single company.

The engineering department of this particular organization is directed by a staff of four executive officers, and the offices of the corporation are scattered over about twenty-five states, Canada and the West Indies. Branch offices are maintained in New York, Chicago, Dallas and Seattle, each in charge of a special representative or district manager. Field engineering or construction offices are opened wherever required, each in charge of a field engineer or superintendent of construction. A definite and aggressive new-business campaign is carried on by the Executive Department at Boston and by the special representatives located elsewhere.

The corporate organization begins with the stockholders and extends through the board of directors and executive committee to the president and general manager, under whom are the first vice-president and treasurer, the vice-president and construction manager, and the vice-president and engineering manager. There are three chief engineers, or consultants, and six division engineers, the former being in charge of electrical, mechanical and hydraulic work respectively, and all reporting to the engineering manager or his assistant. Each division engineer is responsible for the plans, specifications, estimates and correspondence bearing on the work handled by his division, as well as engineering details in connection with contracts for apparatus or material purchased. He makes a monthly report to the assistant to the engineering manager, showing the status of all work under his charge.

The Various Departments

Preliminary estimates are prepared in the Engineering Department, and if these estimates later become a basis for a construction job the estimate is reviewed and checked in consultation with the Construction Department, which adds the detail of overhead or general-expense items, the Accounting Department being consulted on questions of liability insurance and field-office and engineering expense.

Monthly revised estimates, received from the field offices, keep the engineers posted as to the financial status of their work, while daily, weekly or bi-weekly progress reports keep them informed as to the need for plans and material.

Field engineering offices having in charge investigations of hydraulic projects, surveys and the collection of engineering data for report or designing purposes are in charge of a field engineer, who reports to a division engineer at Boston, and in some cases to the engineering manager or the Executive Department.

The chief draftsman ranks as an Engineering Department division head, with a staff composed of an assistant chief draftsman, production supervisor and a force of draftsmen which varies between ninety and one hundred and twenty-five. The normal basis on which the drafting-room force is organized is a system of squads, each made up of men of similar experience, headed by a squad chief, the number of squads depending on the variety of current work.

The squad chiefs deal directly with the engineers, to whom they are responsible for details of design. A sufficient number of potential squad chiefs are attached to the various squads as designers and checkers, so that with the advent of new work they can be detached and placed in charge of new squads, thus providing means for expanding the force with a minimum interference with the work already under way. Assignments reach the squads through the chief draftsman or his assistant, after which the production supervisor is responsible for meeting scheduled dates for the completion of drawings. Records are maintained, both by jobs and by squads, of the number and area of drawings produced and the time required for execution.

Division for Minor Details

The Station Betterment Division is a branch not usually found in engineering and construction companies. It gives the engineers the benefit of actual operating experience on apparatus being selected, as well as in points of design. Also, when the construction work on a new station approaches completion a representative of this division is sent into the field with authority to order and have installed the hundred-and-one little things that go to make the station complete from the viewpoint of the operating force; and with the actual machine, instead of a blueprint, before him, to see that every valve, lubricator or light is in the most convenient location for the operators. These are points which it is almost impossible to adequately cover in plans or specifications. This division conducts initial operation of a new station and makes tests to determine whether new apparatus is performing up to specification requirements.

As the business of the Construction Department is to handle all of the field-construction organizations, it is chiefly executive in its functions. The vice-president and construction manager is keept free of routine and spends a great deal of time on large hydro-electric construction and on the new business and executive problems of the corporation.

He also gives particular attention to any serious field difficulties. He assigns to the three assistant construction managers the responsibility for the direct handling of the field work, which is apportioned among them under a rough territorial division.

In the Northwest and Southwest certain of the functions of the assistant construction managers are performed by the district managers, who are responsible to the Executive Department on all except construction and engineering matters, which they handle through the Construction Department. Each field office is in charge of a superintendent of construction, who reports to an assistant construction manager either directly or through a district manager.

The Estimating Division, while nominally reporting to the Construction Department, is equally available for the Engineering Department. It is the province of the Construction Department to organize and direct all field construction forces, work and equipment; to handle with the client the more important matters arising during field operations; approve for construction features Engineering Department estimates and assume full responsibility for estimates on construction contracts which do not concern the Engineering Department; verify the accuracy of superintendents' monthly revised estimates and assume the responsibility for estimates furnished the client as the work progresses; approve final payments on Boston office contracts; develop systems of bookkeeping and unit-cost records, progress reports and charts; advise Engineering and Purchasing departments as to dates when plans, specifications and material will be wanted; notify sub-contractors when to send machinery erectors, and in general see to it that the job receives what it wants when it wants it. A standard instruction book for field offices, a standard classification of accounts in book form, and a telegraph code assist the field offices in handling routine matters.

Progress Chart

At the beginning of a job all the essential elements entering into its construction are itemized on a progress chart, the sequence of operations and the time required for each being shown graphically. On this basis is prepared a schedule of dates for the completion of drawings, on which the Engineering Department and the field office place all orders for material. The form is printed on tracing cloth, so that the field office can be supplied with a stock of black-and-white prints on which to render periodical reports. This plan sets a pace which must be maintained to bring the job out on time and shows at a glance the effect on the job as a whole of failure to keep up on the schedule on any single item. An intermediate progress report by the construction superintendent sent in at weekly or bi-weekly intervals shows graphically how much work has been done, the time required and the work remaining, with the time necessary to complete it. A monthly letter report covers matters which cannot be shown graphically. A final report filed with the records of the job serves as a basis in making future estimates and comparisons. Errors in original assumptions are emphasized so that the work may constantly be improved.

As soon as the progress chart has been drafted a more detailed list of items is put on a working schedule form. This assigns the responsibility for every item on the job. It is printed on tracing cloth and is made up by the Construction and Engineering departments in conference. It is the most useful single medium of information exchange between the home office and the field. An intermediate working schedule form is also used, which shows the starting of the work on each item and its completion, this being of great assistance to both engineers and construction men in anticipating deliveries of apparatus, men and material. Another useful form is a bill of material originating in the Engineering Department. A single item on the working schedule may correspond to a dozen or more items on this form. As fast as orders are placed, essential information is entered on this form, and each week photostat copies are sent to the superintendent. The field office is thus given exact information as to what has been ordered, the engineer is protected against oversight and the comparison between the estimate and cost of material for each subdivision of the work is kept constantly before him. A delivery schedule is prepared by the purchasing department, with copies for use at the home office and in the field. One copy is returned to the purchasing department, with notes as to what items should have hastened deliveries.

Purchasing and Transportation

The methods of the Purchasing Department as applied to the engineering corporation's work are direct and effective. The buyers place orders on the authority of purchase requisitions and are responsible for price and quality of material purchased, except in case of unusually technical material necessarily purchased under definite specifications by the Engineering or Construction Department.

All orders pass through the Transportation Division, which attends to the routing of shipments so as to secure the lowest freight rates or the quickest delivery. This division also arranges in advance for passenger traffic and for prompt handling of special shipments at transfer points, and, if the importance warrants, sends a personal tracer to travel with the shipment through to destination. It also checks freight bills and makes and handles claims of all kinds with transportation companies. The collections of claims for freight overcharges and the savings due to preventing overcharges by correcting improper routing or classification of shipments amount to several thousand dollars annually.

The province of the Inspection Division maintained by the corporation is to inspect and expedite in every possible way the manufacture and delivery of manufactured material. It is advised by the Construction Department of the speed requirements of each job, and is given detail information on every order placed. Copies of orders, with delivery requirements, are forwarded to traveling inspectors who cover the shops of the manufacturers. This corps of inspectors includes from ten to twenty-five men, some of whom are permanently located in such manufacturing centers as Schenectady, Pittsburgh and Milwaukee. They have the most intimate detail knowledge of conditions in the shops of practically all the principal companies with whom orders are placed, and their daily detail reports keep the Construction Department and the field offices thoroughly posted. This inspection service covers both the quality and delivery of the material.

Accounting Department

The vice-president and treasurer is in general charge of the Accounting Department, which is directly supervised by the comptroller. The assistant treasurer handles the corporation's accounting as distinguished from the construction accounting. He does, however, arrange with clients to meet the cash requirements for each construction job and opens local bank accounts near the construction work through which payroll and other expenditures are handled.

The auditor is responsible for the construction accounting as carried on in the Boston office and all field offices. He also employs and assigns to various field offices the job accountants. He is also responsible for the preparation of the financial reports to clients, for the auditing of field-office-accounting records and for the vouching for payment by the assistant treasurer of all bills rendered on account of Boston orders and contracts and other expenses. He is assisted in the handling of the field accounting by a traveling auditor, who is in the field almost constantly.

A Liability Insurance Division places all liability and other insurance and bonding policies in connection with construction work, being furnished with information by the Construction Department as to the probable payroll and the classes of insurance to be carried. It handles all accident reports and claims and is an authority on insurance matters in general as related to construction work, including the development of compulsory state insurance and workmen's compensation legislation introduced throughout the country.

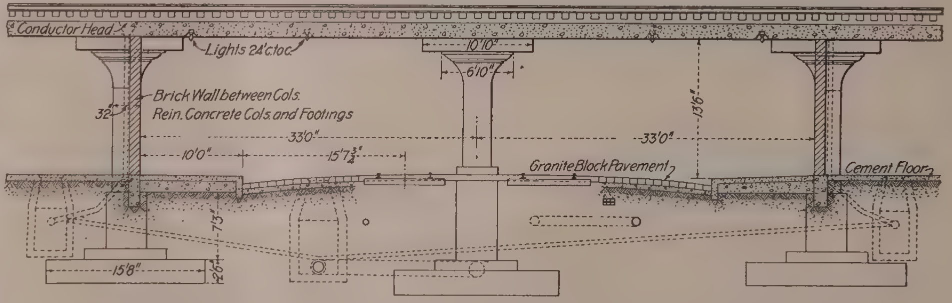
While these departments and divisions are the units in the human machinery which handles most of the work of the corporation, they can be modified so as to meet the requirements of special cases.

Soo Line Freight Terminal in Chicago

Construction of 18-Acre Elevated Storage and Transfer Station and Yard

By the Staff of the Leonard Construction Company, Chicago

In the very heart of the business and manufacturing district of Chicago the Central Terminal Railway (Soo Line) is building a modern elevated freight terminal covering eleven city blocks. The terminal faces at its northern end on the projected Twelfth Street Boulevard, and the plans accord with the widening and beautifying of Twelfth Street, for which the voters of Chicago have already authorized a bond issue. Extending south from Twelfth Street the structure occupies the entire area between Canal and Clinton Streets, crossing Twelfth Place, Thirteenth Street, Maxwell Street, Liberty Street, Fourteenth Street, Barber Street, Fourteenth Place and Fifteenth Street, and then, turning to the west, crosses Clinton, Jefferson and Union Streets and connects with the present Baltimore & Ohio Chicago Terminal Railroad tracks at Halsted Street. The architectural treatment of the terminal buildings has been changed slightly from that shown in the accompanying perspective, which in arrangement of tracks and buildings is correct.



Part Longitudinal Section Through Train Deck at Fourteenth Street Bridge

Alternative Plans

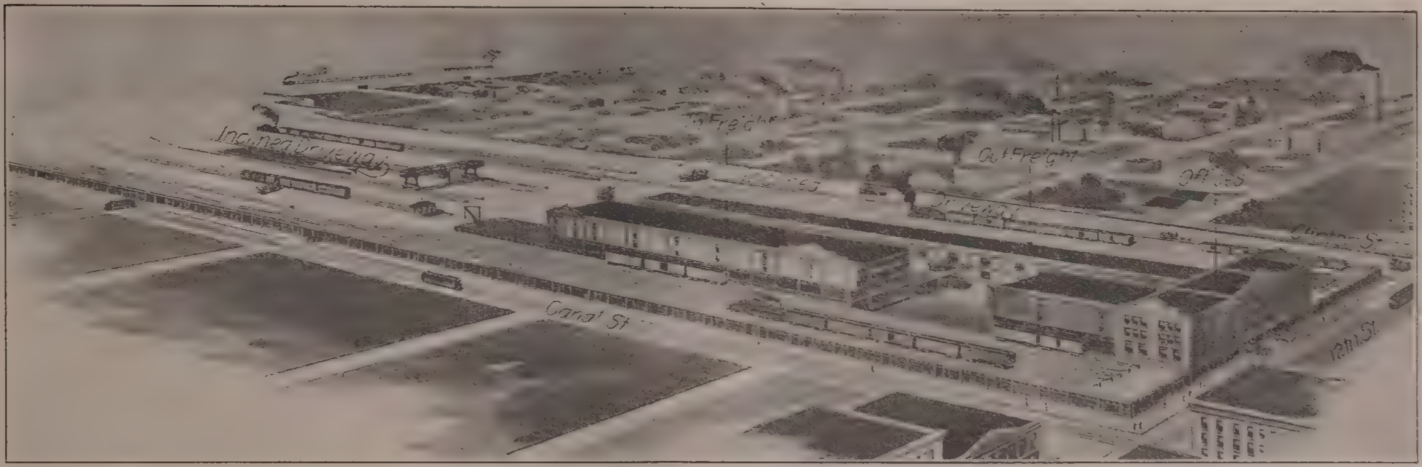
The Chicago freight terminal is to act as the central receiving and distributing station for the Soo Lines, and a very large storage capacity was required for its satisfactory operation. The city would not permit the building of a terminal of this size at the street level, or indeed with any grade crossings. The problem resolved itself, therefore, into two possibilities. Retaining walls could be built along the streets and the area sandfilled, with bridges across the streets and large terminal storage houses in addition to the freight houses required for the actual handling of the freight to and from the cars. This project would have involved 2½ miles of retaining wall 29 ft. high, retaining over 600,000 cu. yd. of fill. To provide equal storage capacity to that shown on the present plans an additional warehouse having 520,000 sq. ft. of floor space would have been required. If this warehouse were built on the same site, over the tracks, it would, of course, be necessary to elevate and lower all the merchandise stored in those higher floors, and the building of the additional warehouse over the tracks would result in the loss of that flexibility in the track arrangement which is a most valuable feature of the present design.

The second possibility is the one embodied in the present plans. The terminal tracks under this arrangement are all carried on a deck structure continuing uninterruptedly across the streets, almost the entire area of the property beneath this structure, except the five streets left open for traffic, being available for storage purposes, amounting in all to more than 600,000 sq. ft. All of this space is at the street level directly accessible to teams for city distribution, and several also by the tracks of the Chicago Tunnel Company. From the street the track deck is reached by two inclined driveways, one from Twelfth Street on the north and the other from Fourteenth Place on the south. These lead directly to the team tracks, the traveling crane and the driveway between the freight houses.

The Chicago Tunnel Company is providing several connections with its system of freight-carrying tunnels which serve all the principal buildings in Chicago. Universal freight station 4 of the Chicago Tunnel Company will be located at Twelfth and Canal Streets under the in-freight tracks. Three elevators connect the tracks of the tunnel company with the tracks of the universal freight station and the tracks in the freight houses of the Central Terminal Railway Company.

Receiving and Shipping Buildings

The freight houses and office building are located at the north end of the terminal adjacent to Twelfth Street. The main in and out-freight houses are at present being built 500 ft. long, provisions being made for a future increase in length. The in-freight house is being built four stories high, but is designed for two additional stories. It is served by five tracks along Canal Street with a capacity of eighty cars. The floor space is about 100,000 sq. ft. as now building, and will be double this when the extensions now



General View of Terminal Buildings and Track Platform, with Freight Storage Underneath

contemplated and provided for are made. The plans call for a cold-storage chamber on the first floor. Five elevators distribute the freight received on the second floor to the upper and lower floors. One tunnel elevator serves the second floor directly. Three spiral chute conveyors are also being installed. At present one scale is provided on the first floor and four scales on the second, set flush with the floor at shipping doors. The plans provide for fourteen team shipping doors on the first floor and nineteen on the second. The entire east side of the in-freight house is open, with columns 20 ft. on centers and with full-width doors between, permitting cars to be spotted with great ease. A screen wall of concrete and brick hides the freight tracks from Twelfth Street Boulevard.

The out-freight house is to be two stories in height and is served by eight tracks with a capacity of 105 cars. The present floor area is 65,000 sq. ft., with provisions for future increase. The freight is received from the driveways through sixteen team doors on the first floor and eighteen on the second. Fifteen scales flush with the floor serve these doors. The entire west side of the second story of the out-freight house is open to the tracks with columns 20 ft. on centers, and full-width doors between. Two freight elevators serve the first and second floors. A 10-ton 20-ft. radius pillar crane for handling heavy castings, etc., will be located on the out-freight platform, so as to serve cars, trucks and platform from one fixed position.

The power and heating plant is located under the out-freight tracks, near Twelfth Street. The coal is received on the west out-freight track and dumped directly into the bin below, and the ashes are hoisted to cars on the same track. Ultimately all heat and power required for the operation of the terminal will be developed by this plant. Provision has been made for future expansion. A reinforced-concrete chimney 140 ft. high is now being constructed there by the Alphons Custodis Chimney Construction Company, of New York.

Driveways and Team Tracks

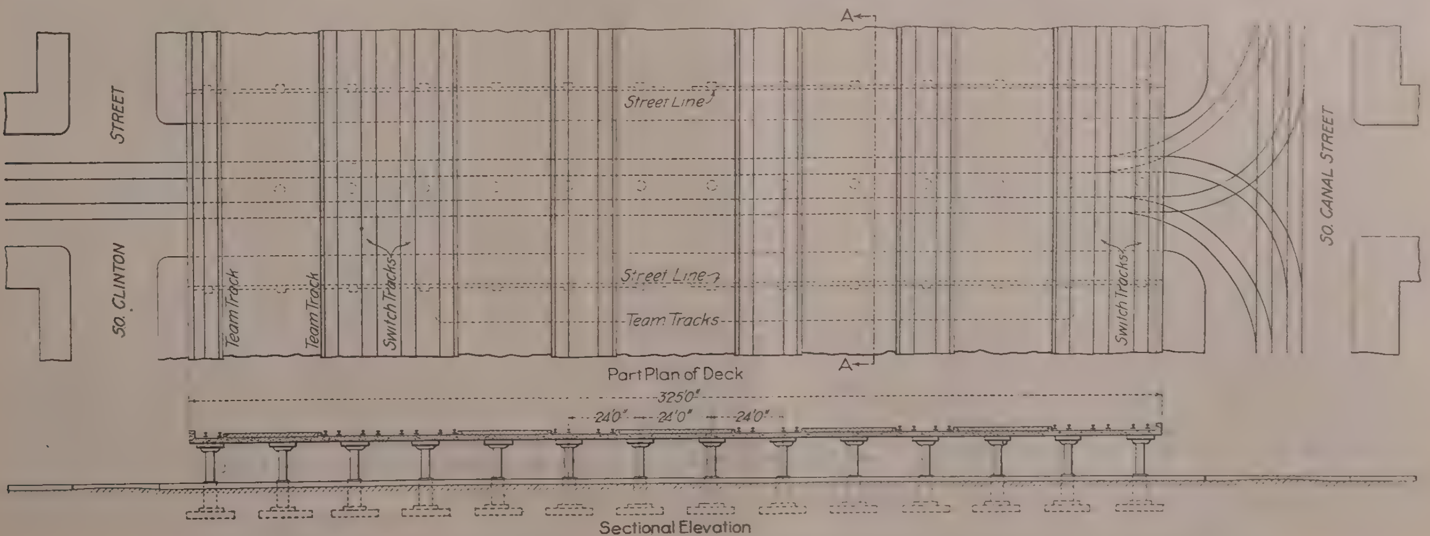
Between the in-and-out-freight houses is a 58-ft. wide driveway on both the ground and second floors. The ground-floor driveway is entered directly from Twelfth, Maxwell and Canal Streets. The second-floor driveway is reached by the inclines from Twelfth Street and Fourteenth Place. The floors of the in and out freight houses are 3½ ft. above top of paving. The second floor of the in-freight house is 4 ft. above the top of in-freight rail, while that of the out-freight house is 4 ft. 3 in. above top of out-freight rail.

Along Twelfth Street, at the north end of the freight houses, the freight and business offices of the Minneapolis, St. Paul & Sault Ste. Marie Railroad will be located in a four-story (ultimately six-story) building, 143½ x 36 ft. in plan. The ground-floor driveway entrance is through this building. The universal freight station of the Chicago Tunnel Company is directly under the in-freight tracks.

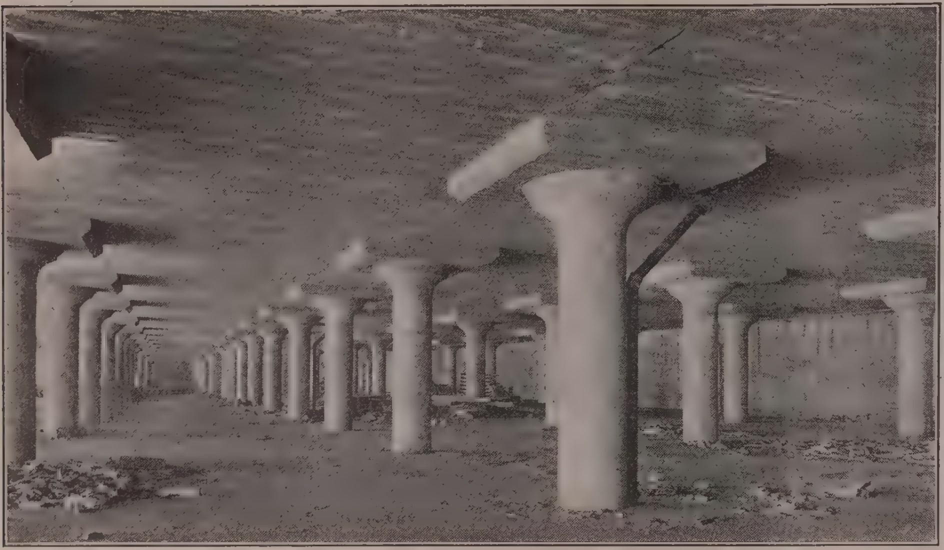
The team tracks are located south of Maxwell Street and have a total capacity of 259 cars, which can be greatly increased when the need arises. A traveling crane serves four tracks near the south inclined driveway. A 9 x 20-ft. auto scale is located in a central position with regard to the inclines and driveways. The flat unobstructed deck permits the tracks to be rearranged at any time as experience may show to be desirable for the more efficient operation of the terminal.

Features of Design

The structure is designed to carry any desired arrangement of tracks at 12-ft. centers and under the heaviest loading which it is considered that the future may by any possibility impose upon them. The track deck is absolutely unbroken by beams and is to be ballasted, permitting unlimited elasticity in the track arrangement. The structure is built of reinforced concrete throughout, with the exception of the columns at the track side of the in-freight house. Concrete was chosen because of lower first cost, lower maintenance cost and greater permanency than structural steel. The use of steel would have required either through girders at the street crossings, so destroying the elasticity of the track arrangement, or else would have elevated the entire structure several feet higher above the street. Structural-steel construction of the same strength and properly fire-proofed would have cost very much more than the present concrete structure. Almost all types of reinforced-concrete construction are to be found in the terminal structure, the requirements of each case being studied and the type best suited being used as a result.



Plan and Sectional Elevation of Bridge at Fourteenth Street Carrying Terminal Tracks over Surface Tracks



Typical Interior View at Street Level, Depressed-Head Construction

For the track slab with the heavy load of ballast and trains figures soon showed that the flat-slab construction with depressed heads led all other types by a very wide margin from the standpoint of cost and desirability in every way. This construction gave an absolute minimum of thickness over the streets, which in turn determined the elevation of the entire structure. For this sort of structure the flat slab is, in the opinion of the designers, and in the light of their computations, absolutely without a rival. In the freight houses proper, with a loading of 350 lb. per square foot, the flat slab also enjoyed considerable advantage in cost over its nearest competitor and made possible a more attractive building.

Tile-Concrete Joists and Reinforced-Concrete Beams

For the office building and the out-freight-house roof, where the loads are light, tile-concrete joist construction was used as being cheaper and somewhat superior in the matters of condensation and noise conduction. For the driveway slab between the two freight houses a reinforced-concrete girder, beam and slab construction was found best adapted. The retaining walls are of a semi-gravity type, being lightly reinforced for temperature and bending stresses. On account of the vibratory nature of the load, deformed bars were used very largely; the Havemeyer bar was selected and was furnished by the Concrete Steel Company, of New York and Chicago. Square twisted bars and a small amount of plain rounds were also used.

The entire deck of the track slab will be waterproofed by the Johns-Manville Company, using three-ply asbestos membrane protected by 1 in. of asphaltic mastic. In general the membrane will not be sealed to the slab but will be entirely loose, except at the downspouts and walls. About 630,000 sq. ft. of slab are to be waterproofed in this manner. Universal Portland cement is being used throughout the work, about 180,000 bbl. being required.

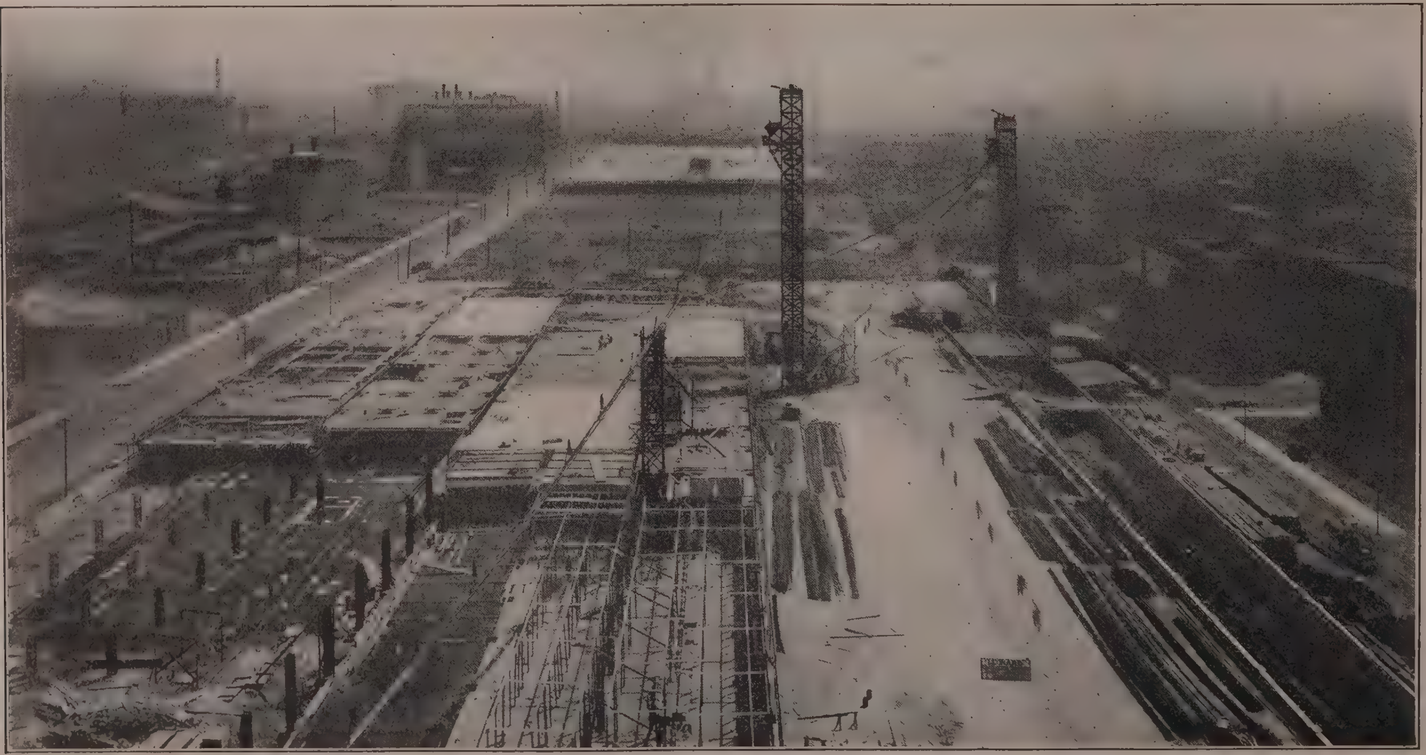
Arrangements are now being made to measure during the coming fall the actual stresses in the steel and concrete of the track slab. Four adjacent panels will be loaded with locomotives and complete measurements made of the resulting stresses under various critical loadings. Dead-load stresses occurring when the forms are finally removed will also be measured.

Construction

Construction work was started on the footings in August, 1912, and continued with a small force, which was increased as rapidly as the clearing of the site and acquisition of property would permit, with very few interruptions throughout the fall and winter. There are about two thousand columns in the project, and on June 15, 1913, all but about seventy-five of the one thousand three hundred and seventy footings had been completed. The footings rest on hard blue clay at El. + 2. Top of slab is at + 31.18 at Jefferson Street, running down at a very slight grade to +26.23 at the freight houses. In May the construction of the track slab was begun and on June 15 about three city blocks had been completed.

The bridge extending across Union Street and the slab across Fourteenth Place are constructed. Work on the terminal freight houses was delayed owing to difficulty and delay in acquiring certain property, but at the present time all but one of the interfering buildings have been razed. All the reinforcing steel in the track slab is being bent in position, which results in a large saving and in better work. The Havemeyer ¾-in. round bars used on the larger portion of the work bend very easily, but the ¾-in. square twisted bars used in one section are very much more difficult to bend, although even here bending in position is believed to be cheaper and preferable to shop bending. The concrete is placed by a combined gravity chute and cart method. With one 33-cu. ft. mixer the output of a single plant runs from 375 to 450 cu. yd. per day of eight hours. Three concreting plants are in continuous operation.

Some of the quantities involved were orig-



Construction View of Main Platform, Showing Towers for Distributing Concrete to Floor Slabs inally estimated as follows, although the final figures may be slightly different:

Excavation		125,000 cu. yd.
Concrete in—		
Track slab and columns		36,300 cu. yd.
Footings		25,300 cu. yd.
Freight and office buildings		13,000 cu. yd.
Retaining walls		13,350 cu. yd.
Driveway and pavements		17,700 cu. yd.
Entire structure about		108,000 cu. yd.
Reinforcing steel		6,500 tons
Area of—		
Ground covered	18.5 acres =	800,000 sq. ft.
Working space	34.7 acres =	1,500,000 sq. ft.
Working space under roof	17.9 acres =	780,000 sq. ft.

The work is now being prosecuted at high speed, and it is expected that the terminal will be completed by Jan. 1, 1914.

The freight terminal of the Central Terminal Railway Company was planned by the Minneapolis, St. Paul & Sault Ste. Marie Railroad Company, of which Mr. E. Pennington is president, and Mr. C. N. Kalk is chief engineer. The engineers and contractors are the Leonard Construction Company, of Chicago, Mr. H. H. Hadsall having general charge of the design and construction for that company. The structural design was licensed and checked by the Concrete-Steel Products Company, of Chicago. Mr. H. Hanselmann, of Chicago, is the architect.

The design and cost computations were made by Mr. E. C. Lord as consulting engineer for the Leonard Construction Company and the design of the track slab was submitted to and approved by Prof. W. K. Hatt, of Purdue University.

Production of Pig Iron

The production of pig iron in the first half of 1913, according to the Bureau of Statistics of the American Iron and Steel Institute, amounted to 16,488,602 gross tons, against 15,654,663 tons in the last half of 1912, an increase of 833,939 tons, or over 5.3 per cent. In the first half of 1912 the output was 14,072,274 tons. Comparing the output in the first half of 1913 with the output in the first half of 1912 shows an increase of 2,416,328 tons, or over 17.1 per cent. A few thousand tons of ferro-phosphorus, ferro-titanium, ferro-vanadium, and other ferro-alloys are included for each of the half years. Combining the output in the first six months of 1913 with the output in the last six months of 1912 a total is reached for the twelve consecutive months of 32,143,265 tons. As compared with the output in the last six months of 1909 and the first six months of 1910, the two consecutive half years of next largest production, when 29,751,863 tons were made, an increase is shown in the first period over the second period of 2,391,402 tons. The production of pig iron in the first half of 1913 was 552,584 tons greater than in the whole of 1908, when the output amounted to 15,936,018 tons. In the first half of 1913 the output of pig iron in this country was considerably greater than the total output in Germany and Luxemburg as late as the calendar year 1911, when the production of these countries amounted to 15,574,039 metric tons. Next to the United States Germany has in recent years been the largest maker of pig iron in the world.

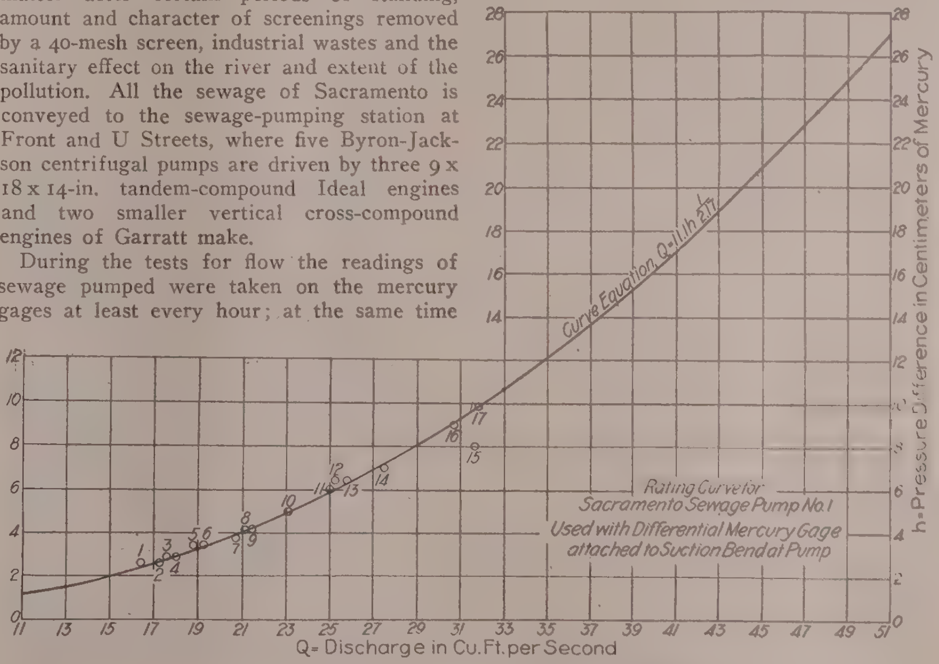
A $2,000,000 MONUMENT for the Alamo heroes has been designed by Herbert S. Green, of San Antonio, Tex. An ornamental tower 802 ft. high and 85 ft. square at the base, with a granite base 50 ft. high, will contain large halls and museums and about 300 rooms for the present and future counties of the State of Texas.

Measuring the Sewage of Sacramento

Variation in Pressure on the Convex and Concave Sides of Pipe Elbows Furnished a Means of Rating the Discharge

Sewage flow and variations in flow in Sacramento, Cal., were determined recently by a rated differential mercury gage connected to the convex and concave sides of 90-deg. reducing bends on the suction lines of the centrifugal pumps which lift the sanitary sewage into the Sacramento River. The gages were calibrated by weir measurement of flow in a 5-ft. outfall below the pumps. The work was carried out in connection with sewage-disposal investigations of the State Board of Health, which covered also a study of the river flow, relation between water consumption and sewage flow, chemical analyses of sewage, the capable-of-settling suspended matter after certain periods of standing, amount and character of screenings removed by a 40-mesh screen, industrial wastes and the sanitary effect on the river and extent of the pollution. All the sewage of Sacramento is conveyed to the sewage-pumping station at Front and U Streets, where five Byron-Jackson centrifugal pumps are driven by three 9 x 18 x 14-in. tandem-compound Ideal engines and two smaller vertical cross-compound engines of Garratt make.

During the tests for flow the readings of sewage pumped were taken on the mercury gages at least every hour; at the same time readings were taken of the water level in the sewer above the pumps. The sewer had been gaged previously for capacity, so that the rate of pumping was reducible to flow-rate by applying a correction represented by the increase or decrease in the water level in the sewer.



Rating Curve for Sewage Pump at Sacramento

FORMULA DEVELOPED

Owing to the stoppage of openings the Pitot tube was considered infeasible for use in sewage and the suggestion to use the suction bends was obtained from thesis experiments made by Messrs. Sooy and Jacobs of the University of California, working in the private laboratory and under the personal direction of Mr. Buckner Speed, M.E., of Berkeley. They determined that the difference in pressure between the convex and concave sides of 3½, 4 and 6-in. bends could be relied upon as a measure of discharge within 2 per cent error. The formula derived from their experiments is:

$$V=C\sqrt[n]{hr/d},$$

where Q = discharge in second-feet; a = area of net cross-section in square feet; h = difference of pressure, or head in feet; r = mean radius of the bend in feet; d = internal diameter in feet; n = an exponent = 1.9 for small bends; A, B and C = constants.

For the range of experiments made, C = 5.58 for a 6-in. elbow, 5.61 for a 4-in. elbow and 5.74 for a 3½-in. elbow. These experiments were performed under conditions of straight approach and discharge on uniform-diameter small 90-deg. bends. At Sacramento the only elbows available were the horizontal reducing elbows on the centrifugal pump suctions where the suction lines enter the pump, thus giving rise to the effects of constricting flow, negative head and runner rotation. Furthermore, the bends were much larger than those experimented with, one being 30 in., two 27 in., reducing approximately 3 in., and two 18 in. in diameter. The 18-in. bends were non-reducing. Each pump gage was actually calibrated by making simultaneous readings of pressure on the differential gages and the head on a special measuring weir constructed in the outfall sewer below the pump.

The differential gages were made at the city sump and consisted of ½-in. glass mercury tubes and ⅜-in. piping tapped into the bends on a horizontal plane through the diameter and as near the center of curvature as possible. Special care was taken to make the taps perfectly normal, although it is stated that this was difficult of attainment. The engineers suggest that the best results are obtained if the pipe taps do not pierce the shell but are merely deep enough to permit good thread connections. The remaining thickness should be pierced by a small drill entering truly normal. The construction of the gages is shown in the photograph.

The readings were taken in centimeters, the millimeter being a fairly close graduation and quickly read.

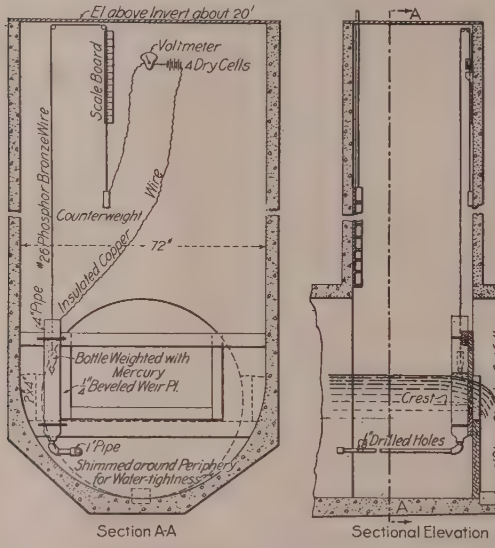
TROUBLE FROM SEWAGE GAS

Much trouble was experienced due to the action of sewage gases, probably hydrogen sulphide, on the mercury. In the course of a few minutes a skin would form on the surface of the mercury otherwise clean, which made readings almost impossible. This difficulty was not overcome entirely but was remedied by pouring a small quantity of alcohol in each leg, which had the effect of dissolving, or at least preventing the adhesion of the mercury skin to the glass. However, the alcohol soon colored so highly that it was impossible to read the meniscus of the mercury, and most of the readings were taken at the periphery of its surface.

The weir in the outfall was of the sharp-edged type, with end contractions set in a bulkhead braced in a gate chamber about 500 ft. below the city-pumping station. The scheme included a baffle wall set in the circular sewer about 15 ft. upstream to break up the high velocity of approach, about 2 ft. per second. This arrangement, finally abandoned, soon clogged with newspapers and other floating material, in spite of the fact that the sewage had passed through a 1½-in. bar screen.

MEASUREMENT OF HEAD

Much difficulty was experienced in devising a satisfactory means of head measurement. The first arrangement consisted of a 1-in. pipe extending through the weir bulkhead upstream and capped at the upper end. There were two pairs of ⅛-in. perforations about 1 ft. from the top. On the downstream side a 60-ft. length of hose, laid on the invert, was led beyond the sewer outfall mouth and back on the river bank, where it connected with a stilling chamber consisting of a cylinder 8 in. in diameter by 3 ft. high. A gage glass was attached to the outside of this cylinder and readings of the water level in the tube were taken on a scale board set behind it. On account of gas formation in the sewage in the hose and the absence of any grade, which made it difficult for the hose to free itself from gas accumulations, it was impossible to get correct readings of head. Finally, however, a quite satisfactory scheme involving electrical contact was rigged up.



Sectional Elevations of Measuring Weir

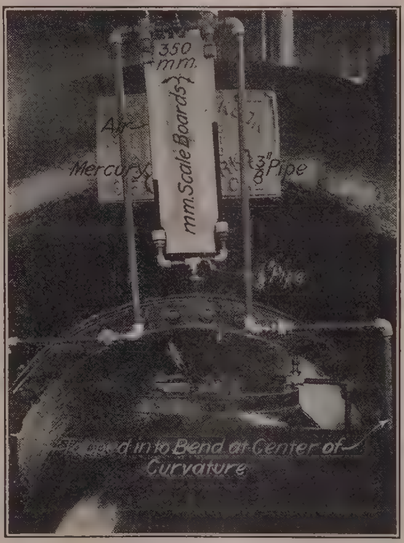
As shown in the accompanying drawing, the electrial device consists of a 4-in. pipe set vertically on the upstream face of the bulkhead to act as a stilling chamber. The head was transferred to this pipe through a 1-in. capped and perforated pipe, about 4 ft. long, directed upstream.

In order to make it possible to read the gage in a pleasant atmosphere the scale board was placed at the top of the gate chamber. An inverted bottle, weighted with mercury, with a needle in its cork, was hung by a piece of phosphor-bronze wire passing over a pulley and down in front of the scale board. An electrical circuit was run from the 4-in. pipe through a sensitive voltmeter and four small dry cells, also connecting with the wire from which the needle and bottle weight hung. A circuit was completed when the needle touched the sewage level, as indicated by a deflection of the voltmeter needle. The readings of a fixed mark on the scale board gave the head on the weir.

A rating curve for the weir was calculated by the Francis formula for end contracted weirs and by the Hamilton-Smith formula and coefficients. Velocity of approach was considered in the proper way for both calculations. A mean curve was used.

In calibrating the mercury gages the rate of pumping was varied by changing the steam pressure, hence the revolutions per minute, and by varying the head pumped against by opening and closing, as desired, a gate on the discharge line. After any change it required about twenty minutes for conditions to become normal at the weir.

On account of the fact that a weir large enough to carry the maximum rate pumped could not be constructed, it was necessary to experiment on low heads and exterpolate the curves by the formulæ for the usual running conditions. It is not thought, however, that any other influence would come in than the velocity in the bend. A precision greater than 5 per cent was of no value.



Air-Mercury Differential Gage

These investigations were carried out by Mr. C. G. Gillespie, acting under the direction of Prof. Charles Gilman Hyde, of Berkeley, Cal., consulting engineer to the State Board of Health.

THE NEW WATERWORKS AT COLON, in the Canal Zone, as originally planned were to utilize the three boilers, two stacks, and three pumps in the old station, but upon examination it was found that their condition would not justify their installation in a new plant. It has now been decided, says the "Canal Record," to substitute electrical for steam energy, and to install three motor-driven, single-stage pumps, using 2200 volts. The average loads on these pumps will probably be less than 200 hp a day. It is believed that the operating expense will be considerably less with motor-driven than with steam-driven pumps, while the electrical installation will leave a space approximately 28 x 35 ft. available for the installation of oil pumps for the fuel oil pipe-line system.

Completing a Belated Skyscraper

Occasionally the framework of a steel building is designed to provide for the future construction of a number of additional upper stories, the columns and foundations being proportioned to receive stresses developed by the future increase of loading.

Important examples of such provision are afforded by the New York terminal station of the New York Central & Hudson River Railroad, recently described at length in these columns, and the Post Office building adjacent, both of which are intended to receive many additional stories when conditions justify or demand their construction. In these cases the upper stories have not yet been built, but in the case of the First National Bank Building in Pittsburgh, with fronts of 87 ft. on Fifth Avenue and 150 ft. on Wood Street, the original structure, which was built to a height of five stories in 1907, was extended last year to a height of 26 stories without interrupting the service of the building or disturbing its tenants. The fifth-story columns projected above the sixth floor, which formed the temporary roof, far enough to provide for splicing on the new sixth-story columns without interfering with the structure below, thus enabling the new work to be executed very much as if it were a separate building starting from a foundation platform.

PROTECTION SHIELDS

The sidewalks on both fronts of the building were first covered by heavy bridges of the ordinary type, to serve both for protection and to afford working and storage space, and above them a second intercepting platform 12 ft. wide was built of 3-in. planks with a capacity of 3000 lb. per square foot, supported on wooden cantilevers projecting through the fifth-story windows and reacting upward against the sixth floor or roof beams of the original structure. The upper platform not only provided convenient working and storage space but served as an additional safeguard against falling materials. The roof was covered with a protecting floor of 2-in. planks that provided a working surface and prevented injury to the permanent structure.

ERECTION OF STEELWORK

All hoisting was done at night by two wooden derricks with 85-ft. booms, which were installed on the roof and by a hod hoist placed in the shaft built for the permanent elevator cars. All of the steelwork was erected by day without serious inconvenience from dust, noise or other annoyance to the occupants of the bank and other tenants of the building. The steel was erected at the rate of two tiers or four stories per week, and the terra-cotta walls were built at the same rate. An air compressor was installed in the cellar to furnish the power for driving the rivets in 5000 tons of structural steel. The hollow-tile floors were laid at about the same speed as the buildings, and walls were built and the work, commencing in October, was finished without accident in April by an average force of about 500 men under the direction of Mr. A. H. Petersen, superintendent of the Thompson-Starrett Company, the contractor.

LARGE RESERVOIRS for irrigation and hydroelectric-power purposes, involving an expenditure of about $12,000,000, are proposed on the Sila River in Calabria, Italy. The plans have met with the approval of the Italian Government and a bill authorizing the work is now before the Parliament.

Flow over Model of Sunol Dam

Tests by Which the Discharge over the Main Structure Was Estimated

By Joseph N. LeConte, Assistant Professor of Mechanical Engineering, University of California

The Sunol dam is a concrete structure about 151 ft. in clear width, erected by the Spring Valley Water Company, of San Francisco, Cal., to divert the waters of Alameda Creek, which furnishes one of the main sources of supply to the city of San Francisco. The dam was put in for diversion purposes only, but for twelve years past gage heights of the waste-water surface have been kept by the company, from which data, together with the known diversion to the Belmont Pumping Station, the approximate run-off of the creek basin has been computed.

Recently, due to the increasing importance of this source of supply, more accurate relations between these gage heights and the corresponding rates of flow have been demanded, and in order to determine as nearly as possible the run-off in years past Mr. F. C. Herrmann, engineer of the Spring Valley Water Company, suggested that experiments be made on a model of the dam, which might with reasonable certainty be extended to give corresponding flows over the large structure.

Alameda Creek above the Sunol dam drains about 620 sq. miles of the coast range of mountains and discharges into the southern end of San Francisco Bay. It is subject to extreme variations in flow. At certain abnormally rainy periods it has been known to carry for a short time as much as 28,000 sec.-ft., while in the dry summer months it falls as low as 15 to 20 sec.-ft. These periods of extreme flood do not occur regularly every winter, but several years may intervene between them. Nevertheless, since the watershed contains several very large reservoir sites in the valleys above Sunol the determination of these "peak flows" is of the greatest possible importance, and it was for the determination of them principally that the following work was undertaken.

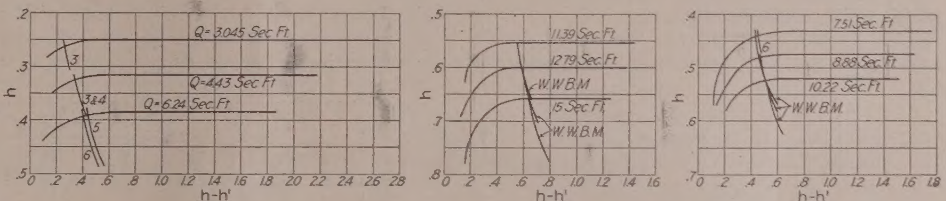
The Sunol dam is a rectangular weir of slightly irregular form. Beginning at the south bank the first 135 ft. of the crest are level, and from this datum the gage heights have been measured. The last 16 ft. near the north end are level also, but about 3 ft. higher than the main crest. The ends of the notch are vertical. The wall extending from the south end of the notch to the bank is vertical, parallel with the crest, and flush with the upstream face of the dam, giving the effect of end contraction to the escaping stream here. At the north end of the notch the vertical wall of the forebay extends 12 ft. upstream at right angles to the crest and then merges into the wing wall which extends to the north bank, making an angle of about 45 deg. with the crest. The construction practically suppresses the end contraction on this side. The main crest of the dam stands only about 3 ft. above the stream bed at a point 100 ft. upstream, but gravel has been washed against the upstream face almost level with the crest. At flood stages this does away almost entirely with bottom contraction. The downstream bed of the creek has been scoured out by the overfall to something like 15 ft. below the crest. These conditions must of necessity change somewhat during flood, but of course no measurements are possible at that time. The location of the regular gaging scale is not in midstream and beyond the influence of the surface curve, but is on the wing wall of the north bank, well within the influence of the surface curve. Furthermore, at times of high and moderately high water the stream discharges against a submerged head, and no record has been kept of the amount of this submergence corresponding to different gage heights.

These various complex conditions make the computation of the discharge curve so difficult that tests on a model seem to furnish the best solution until actual current-meter measurements can be made.

The model was constructed of wood exactly 1/20 the size of the large dam in every dimension. The upstream channel was made of cross-section similar to the present cross-section of the stream bed above the large dam. As has been stated, this section may have been different at times of high water, but no better data are obtainable. The stakes and other bench marks from which gagings were made were located in their proper positions. In addition to this is a hook gage reading to 0.001 ft. was located in midstream 5 ft. above the crest of the model, and the main upstream head was taken with this. A 2 x 6-in. timber was placed across the channel 5 ft. downstream from the crest, and this furnished a bench mark from which the downstream surface, and hence the submergence, could be measured. Baffle boards about 40 ft. downstream served as a means of varying the submergence through any required range. The flow over the model was measured by means of two 30-in. sharp-edged, fully contracted weirs, the weir box being amply large to eliminate the effects of velocity of approach to these. The head on the weirs was taken on a standard hook gage reading to 0.001 ft.

The testing box was located on San Mateo Creek and was fed by water from the flume leading from the first Pilarcitos tunnel. Main adjustment of the supply was effected by operating the gates at Lake Pilarcitos. Closer adjustment was obtained by wasting water above the weir box into San Mateo Creek.

The test on the Sunol model was made on June 13, 1912. The hook gages were leveled with reference to the dam and weir crests with an engineer's level, and all bench marks were leveled in a similar way. The Pilarcitos gates were opened about 3 in., giving a discharge of



Curves Showing Relation of Upstream Head to Submergence

Log of Tests from Which Curves Are Plotted

No.	Weir hook	Dam hook	Back water	Position of gage	Gage reading	Weir hook	Dam hook	Q	h'	$\frac{h-h'}{h}$	Gage reading	Readings, Stake 6
1	1.419	1.058	20⅛	1 Down	15/16	0.963	0.659	15.00	—0.172	1.261	0.639	..
	1.419	1.058	15	1 Down	15/16	..	0.659	..	+0.255	0.613	0.639	..
	1.419	1.068	13½	1 Down	15/16	..	0.669	..	0.385	0.425	0.639	..
	1.419	1.096	12	1 Down	½	..	0.697	..	0.505	0.276	0.675	..
	1.419	1.179	10¼	1 Down	¾ in. over top of forebay	..	0.780	..	0.654	0.1615	0.779	..
2	1.320	0.999	20¾	1 Down	1⅝	0.864	0.600	12.79	—0.225	1.375	0.582	..
	1.320	0.999	14⅝	1 Down	1⅝	..	0.600	..	+0.287	0.519	0.582	..
	1.320	1.016	13	1 Down	1 7/16	..	0.617	..	0.422	0.316	0.597	..
	1.320	1.035	12½	1 Down	1¼	..	0.636	..	0.465	0.269	0.613	..
	1.320	1.063	11¾	1 Down	13/16	..	0.664	..	0.525	0.209	0.649	..
	1.320	1.092	10¾	1 Down	⅜—	..	0.693	..	0.609	0.121	0.686	..
3	1.254	0.952	21	1 Down	2⅛	0.798	0.553	11.39	—0.245	1.443	0.540	..
	1.254	0.952	15	1 Down	2⅛	..	0.553	..	+0.255	0.539	0.540	..
	1.254	0.959	13⅝	1 Down	2+	..	0.560	..	0.370	0.340	0.550	..
	1.254	0.980	13	1 Down	1¾	..	0.581	..	0.422	0.274	0.571	..
	1.254	1.004	12	1 Down	1½	..	0.605	..	0.505	0.165	0.592	..
	1.254	1.029	11⅝	1 Down	1 5/16	..	0.630	..	0.536	0.149	0.608	..
4	1.197	0.918	21¼	1 Down	2 9/16	0.741	0.519	10.22	—0.265	1.510	0.503	..
	1.197	0.918	15¾	1 Down	2 9/16	..	0.519	..	+0.193	0.628	0.503	..
	1.197	0.932	14¼	1 Down	2⅜	..	0.533	..	0.318	0.404	0.519	..
	1.197	0.947	13⅜	1 Down	2 3/16	..	0.548	..	0.391	0.287	0.535	..
	1.197	0.981	12½	1 Down	1¾	..	0.582	..	0.464	0.206	0.571	..
5	1.130	0.874	21⅝	1 Down	3 1/16	0.674	0.475	8.88	—0.298	1.627	0.462	..
	1.130	0.874	16	1 Down	3 1/16	..	0.475	..	+0.172	0.638	0.462	..
	1.130	0.885	14½	1 Down	2 13/16	..	0.486	..	0.296	0.391	0.483	..
	1.130	0.898	14	1 Down	2 11/16	..	0.499	..	0.339	0.321	0.493	..
	1.130	0.918	13⅜	1 Down	2½	..	0.519	..	0.391	0.247	0.509	..
	1.130	0.968	12 3/16	1 Down	1 11/16	..	0.569	..	0.490	0.139	0.576	..
6	1.058	0.829	22	6	¼	0.602	0.430	7.51	0.330	1.767	0.425	0.439
	1.058	0.829	15⅞	1 Down, 6	3½, ¼	..	0.430	..	+0.132	0.693	0.425	0.439
	1.058	0.839	14⅞	1 Down, 6	—3⅜,—⅛	..	0.440	..	0.265	0.398	0.436	0.450
	1,058	0.856	14½	1 Down, 6	3¼, 0	..	0.457	..	0.297	0.350	0.446	0.460
	1,058	0.890	13¼	1 Down,	2 13/16	..	0.491	..	0.401	0.183	0.483	
	1.058	0.969	12	1 Down,	1 15/16	..	0.570	..	0.505	0.114	0.555	
7	0.986	0.782	22	5	⅛	0.530	0.383	6.24	—0.329	1.859	0.400	..
	0.986	0.782	17	5	⅛	..	0.383	..	+0.089	0.768	0.400	..
	0.986	0.785	16	5	0—	..	0.386	..	0.172	0.555	0.410	..
	0.986	0.793	15½	6	11/16	..	0.394	..	0.214	0.457	0.403	..
	0.986	0.805	14½	6	9/16	..	0.406	..	0.297	0.268	0.413	..
	0.986	0.839	13⅜	6	⅛	..	0.440	..	0.401	0.089	0.446	..
8	..	..	..	..	..	0.419	0.316	4.43	—0.370	2.170	0.334	..
	..	..	..	..	..	..	0.318	..	+0.140	0.560	0.334	..
	..	..	..	..	..	..	0.323	..	0.203	0.371	0.339	..
	..	..	..	..	..	..	0.353	..	0.297	0.1586	0.368	..
9	..	..	..	..	..	0.325	0.249	3.045	—0.411	2.650	0.248	..
	..	..	..	..	..	..	0.249	..	—0.079	1.317	0.248	..
	..	..	..	..	..	..	0.249	..	—0.005	1.020	0.248	..
	..	..	..	..	..	..	0.250	..	+0.130	0.480	0.248	..
	..	..	..	..	..	..	0.283	..	+0.245	0.134	0.284	..
10	..	..	..	..	..	0.226	0.187	1.795	..	..	..	..
	..	..	..	..	..	0.105	0.090	0.577	..	..	..	..

Zero reading on dam hook = 3.99 ft.; level on dam crest = 5.173 ft.; level on timber 5 ft. below = 3.668 ft.; level on timber 15 ft. below = 3.652 ft.; length of crest 6 ft. 9 in. + 9⅝ in.; zero of hook gage on weir = .456.

about 15 sec.-ft., which corresponded on the model to high water. The hook gage on the weir was set and read. All baffle boards were removed, so that the model dam had a clear overfall. The hook gage above the dam was set and read (h). With an ordinary rule the position of the surface at the gaging point was then noted (g). Then the position of the downstream surface was measured with a rule, giving the downstream head, h'. Owing to the disturbed condition of this surface no more accurate method of measuring was necessary.

Allowing the same quantity to flow over the model, baffle boards were inserted below so as to raise the downstream surface, and the above-described measurements were repeated. Then more baffles were put in, and so on, until 5 to 7 complete sets of measurements had been made on one rate of flow and until the ratio $h - h'/h$ dropped to about 2/10 or less.

The waste gate above the weir box was then opened a small amount, allowing less water to pass over the weirs and to the model. After conditions became steady the entire set of measurements was repeated, starting with a clear overfall.

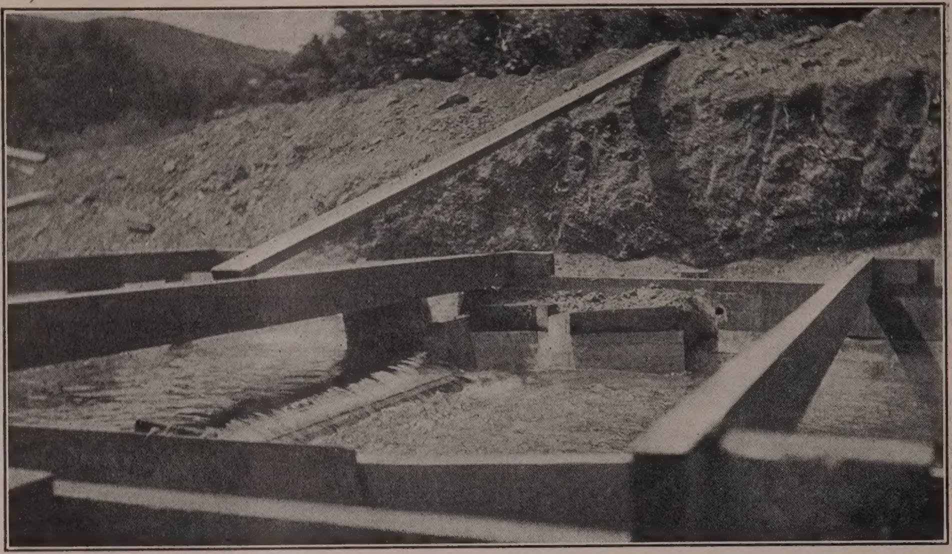
This method was followed until the quantity was reduced to as small an amount as the 30-in. weirs could handle.

The discharge curves for the model were first computed. The flow over the sharp-edged weirs was computed by means of the standard formula

$$Q = \tfrac{2}{3}\, c\, b\, h^{3/2} \sqrt{2g},$$

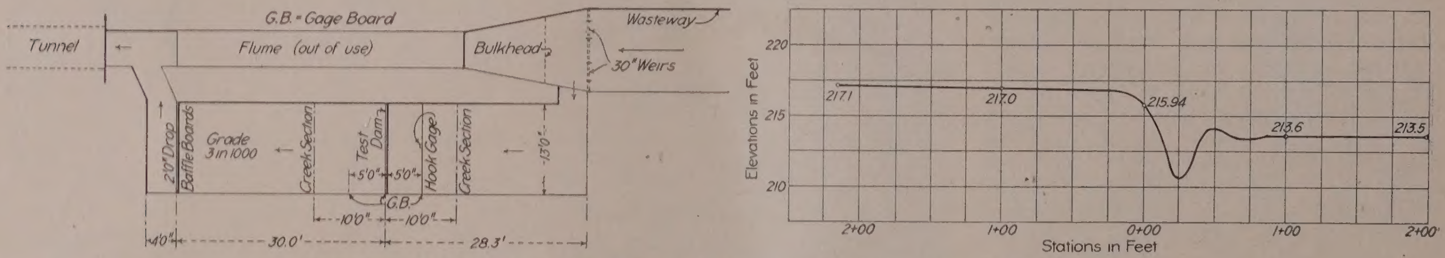
the coefficient c being taken from Hamilton Smith's tables for contracted weirs.

For each complete set of measurements—that is, for each single value of Q—a curve was plotted showing the relation between $\frac{h - h'}{h}$ (which may be called the submergence ratio) and h the upstream center head. One fact is clearly seen from this set of curves—namely, that h is constant or is unaffected for all ratios of submergence down to about 6/10 or ½. It may be stated that the effect of back water down to ratios of submergence of ½ is so slight as to be practically negligible on the model. In these tests with a given upstream head h, the quantity flowing over is practically the same for a submergence of ½ as it is for a free overfall. As the ratio $h - h'/h$ is reduced below ½, the upstream head h begins to rise, at first slowly and then more rapidly, the condition $h - h'/h = 0$ being manifestly impossible.

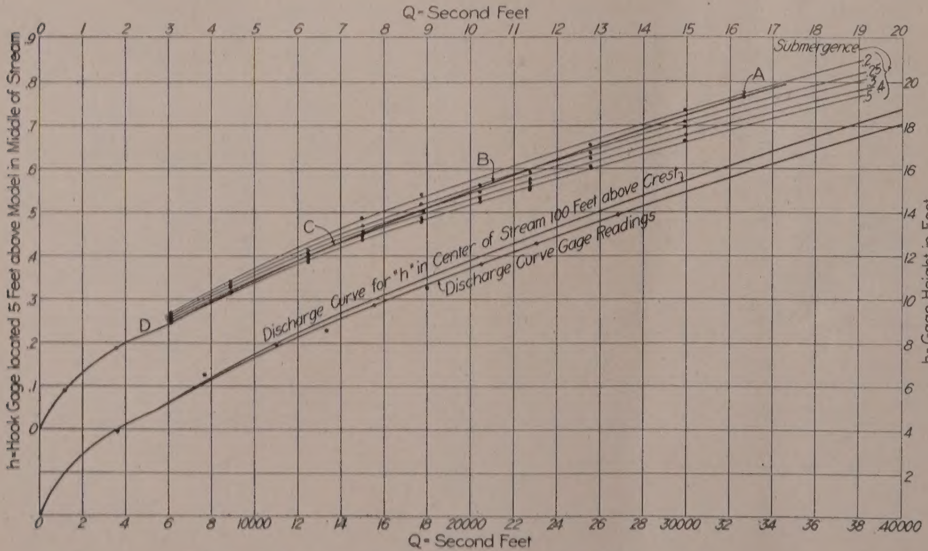


Arrangement of Weir Where Flow Measurements Were Made

Next the discharge curves for the model are plotted. These curves show the discharge over the model in second-feet in terms of the midstream hook-gage head 5 ft. upstream. The lowest curve is for a submersion ratio of 5/10, and this curve also corresponds to all larger ratios, including free overfall. The next curve above is for a ratio of 4/10, etc. These are rating curves exactly as measured and bear no relation to any discharge formula. All effects of velocity of approach and of variable cross-section of the escaping stream are included in them.



Arrangement of Test Flume at San Mateo Creek and High Water Line at Dam March 6, 1911



Curves Showing Discharge over the Model Sunol Dam

So far the problem is merely one of measurement or calibration of the model. In the extension of these results to the large dam, however, it is a matter of theoretical investigation purely. Apparently the required result can be obtained in the following manner:

The point given by the high-water marks of the great flood of 1911 can be located at A on a reduced scale of heads, but for identical submersion and a probable discharge curve $ABCD$ for the model can be drawn. This curve, of course, must be located within the given limits by judgment. The point A is taken as a known point. Toward D we know that the actual curve will merge into the curve of ½ submergence ratio. Between these points the probable curve has been drawn cutting across the others. Its location as shown is believed to be conservative. This would represent the discharge over the model if operating under a *varying* submersion in exactly the same way that the large dam operates.

The standard formula for a free overfall of any sort is

$$Q = c_1 b h^{3/2}.$$

If h_v is the head corresponding to a velocity of approach,

$$Q = c_2 b [(h + h_v)^{3/2} - h_v^{3/2}].$$

For a submerged weir

$$Q = c_3 b [h_2^{\frac{1}{2}} (h - h_2/3)]$$

where h_2 is the difference in level between the upstream and downstream surfaces, or $h_2 = h - h'$. Finally, if velocity of approach is taken into account,

$$Q = c_4 b [(h + h_v)(h_2 + h_v)^{\frac{1}{2}} - \tfrac{1}{3}(h_2 + h_v)^{3/2} - \tfrac{2}{3} h_v^{3/2}]$$

Now if a weir or dam is increased in all its linear dimensions n times,

$$b' = nb \quad h' = nh \quad h_2' = nh_2 \quad h_v' = nh_v.$$

This latter, though slightly approximate, may be seen as follows: The flow over a dam varies as the 3/2 power of head and directly as the breadth, or as the 5/2 power of n. But the cross-section of the approaching channel varies as the square of n, hence the velocity of approach or Q/A varies as $n^{5/2}/n^2 = n^{1/2}$, and the head corresponding to this, or $h_v = v^2/2g$, varies directly as n.

Hence, substituting in the above formula for the submerged weir, we have:

$$Q' = c_4 nb\,[n(h + h_v)n^{1/2}\,(h_2 + h_v)^{1/2} \ldots - \tfrac{1}{3}n^{3/2}(h_2 + h_v)^{3/2} - \tfrac{2}{3}n^{3/2}h_v^{3/2}] = Qn^{5/2}.$$

Therefore, in order to exaggerate the discharge curve of the small dam to such a scale as to make it represent the probable discharge over the large dam, we must multiply the head h by n and the discharge Q by $n^{5/2}$.

The above mathematical result simply means that for a weir of any sort the coefficient c is constant for a given ratio of breadth and depth.

Unfortunately, experimental evidence is lacking upon this last point in the case of broad-crested weirs and dams, and even on sharp-crested weirs for any such widths as 150 ft. However, the above law holds quite accurately (within 1½ to 2 per cent) for sharp-crested weirs from widths of 7 ft. and heads of 3/10 ft. up to the largest widths upon which we have data. Taking Francis' formula for the suppressed weir,

$$Q = 3.33\,bh^{3/2},$$

c is constant and equal to 3.33 for all sizes and shapes within reasonable limits. In the formula for the contracted weir

$$Q = 3.33\,(b - 0.2\,h)h^{3/2} = cbh^{3/2},$$

$$c = 3.33\,(b - 0.2h)/b = 3.33\,(1 - 0.2h/b)$$

which is constant for a given ratio of head and breadth. The same will be true if the velocity of approach is taken into account. In the case of the triangular notch, where b and h are in constant ratio for all heads, c is known to be absolutely constant for large notches.

It may be argued that while the above may be true for large structures the law would not hold for so small a model as 7½ ft. width, or one-twentieth the size of a large weir. But if the curves of the coefficient c in terms of head h and for different breadths of notch up to 19 ft. be examined in Hamilton Smith's "Hydraulics" ("Hydraulics," by Hamilton Smith, Jr., Plate VII) it will be noted that the constancy of this coefficient holds within 2 per cent throughout the entire range of contracted and suppressed weirs down to a breadth of 7 ft. and head of 3/10 ft.

If the constancy of the value of this coefficient for a given ratio of b and h be admitted, the method of computing the flow over the Sunol dam by means of tests on models becomes quite independent of any weir formula whatever.

Now in the case of the Sunol dam, $n = 20$, $n^{5/2} = 1789$. With this the discharge curve is computed.

Finally, for each hook-gage reading on the model we have a surface measurement corresponding to that of the main gage on the dam. The ratio of these two measurements is taken directly from the figure, where the readings are plotted along the short cross-curves. The lower discharge curves show the flow over the dam in terms of the gage head. This last is the one which would be used in computing the flood discharge of the creek in years past.

In summing up the probable sources of error in the above method we may consider them under the following heads:

1. Errors in the hydraulic measurements of the flow over the model.
2. Errors in drawing the curve *ABCD*.
3. Errors in assuming the flow over similar dams to be proportional to the 5/2 power of their linear dimensions.
4. Errors in the construction of the model—i.e., in reproducing on an exact scale of 1/20 all features of the dam and the channel at the time of the floods.

In regard to 1, the results of the model test speak for themselves. In regard to the curve *ABCD*, very little change is possible. The most important part for high heads is controlled by the known point *A*. The third possibility of error has already been discussed. The fourth is, of course, the most difficult to satisfy. No measurements of the channel were or could be made at time of flood, and the form was probably somewhat unstable in any case. The channel approaching the model was made as nearly as possible like the stream bed when dry and with the same slope.

Measuring British Columbia Water Powers

In compiling data for a more complete report on the water powers of British Columbia the Canadian Conservation Commission has recently sent out surveying parties who will spend the present season in field work. Two parties were dispatched from Victoria to gage the flow in the principal streams that empty into the inlets between Powell River and Prince Rupert on the mainland. Other parties are outfitting at Hazleton for similar work along the Skeena, Upper Skeena, Babine and Bulkeley Rivers and tributary waters. An investigation of water-power resources on Vancouver Island is also being carried on in cooperation with the water branch of the Provincial Department of Lands.

The proposed report on the water powers of British Columbia is to include collateral information which is now being compiled, including a recapitulation of the laws and regulations relating to rights and privileges already granted by the province for mining, irrigation and other purposes. The water problems of British Columbia are said to be more complex than in any other province of the Dominion, chiefly because water rights have been recorded there antedating those of all the other provinces, a total of about 5000 water records being in existence, granted under various terms and conditions. The rights of early recorders often call for special consideration by the water branch of the Department of Lands. Mr. A. V. White, of Toronto, chief engineer of the Conservation Commission, is in charge of the British Columbia surveys and investigations.

Letters to the Editor

Code of Ethics of the Pacific Northwest Society of Engineers

Dear Sir: Referring to the letter of Mr. W. H. Drane on page 112 of the Engineering Record of July 26, and to the code of ethics of the Pacific Northwest Society of Engineers printed in your paper July 12, page 50, allow me to state, as a member of the committee which drafted this code of ethics, that it has not yet been adopted . [A letter to this effect from the secretary of the society was printed in last week's issue of the Engineering Record.]

This code is the result, to date, of committees from two engineering bodies located in Seattle, the writer being a member of one committee and chairman of the other.

It is a combination of the American Institute of Consulting Engineers' code of ethics and that of the Boston Society of Civil Engineers, with some minor modifications in each. The former code admirably defines what is unprofessional and the latter equally as well defines the general principles of engineering ethics.

Both committees have been continued to consider suggestions as to rearrangement of paragraphs and slight modifications in the wording, and the code is then to be put to letter ballot in the Pacific Northwest Society. The younger association will undoubtedly take it as finally adopted in the older society, for the sake of uniformity.

Mr. Drane suggests that some form of penalty should be provided for violation. This matter was considered by our committee, and it was thought best that such provision should be made in the by-laws of the society rather than appended to the code.

The last paragraph of Mr. Drane's letter is a challenge which I desire to answer.

When there is only one society for each branch of engineering, with rigorous membership requirements and a comprehensive code of ethics, with provision in the by-laws for eliminating members addicted to unprofessional conduct, then there will be no necessity for a license law, and the public will regard us with entire confidence.

Local engineering societies would have no further reason to exist, as branches of the parent societies could be organized—such as now exist in the various associations of members of the American Society of Civil Engineers. Think of the tremendous influence associations would have in their various communities with the weight of the whole parent society behind them on questions of broad engineering policy.

The conditions that exist to-day tend directly to confuse the public. Take the case of Seattle, for example, where there are four engineering bodies in which civil engineers probably predominate, viz.: the Pacific Northwest Society of Engineers, the Engineers' Club, the Washington Association of Engineers and the Seattle Association of Members of the American Society of Civil Engineers. There are members enough in each one, probably, that belong to none of the other three, so that each society might present a different view on some particular local civil-engineering policy. How would the public decide to which society they should listen? Would the public not be likely to form an adverse opinion of civil engineers generally?

In what local society do you find a good proportion of, say, chemical engineers in attendance when the paper of the evening is on purely civil-engineering lines, and vice versa? Hence the small attendance and apparent lack of interest. The various branches of engineering have little in common in such a society. They would have a great deal in common in an engineers' club. There are questions of local importance that need to be discussed by such bodies more in a social than scientific way. The engineers' club, therefore, has an important place in a community.

A concentration of effort on one society would save an immense amount of energy and time which is now distributed in a perfunctory way among several organizations. It would furthermore, reduce an engineer's living expenses. But, best of all, it would vastly strengthen our various national engineering bodies, it would give them power to guard the interests of the profession, and would give us a standing with the public such that the utmost confidence would be placed in us. An engineer's certificate from his national society would carry more weight than a license granted by some body of politicians.

Seattle, Wash. H. F. Tucker.

Some Observations on Paving and Road Matters in England

Dear Sir: By far the greatest benefit derived from attendance at the recent International Road Congress in London was through the opportunities offered for inspecting roads in the neighborhood of London and the exhibits held in connection with the congress.

At these the exhibits of the Road Board of Great Britain had an important place. This board was constituted in 1910 in consequence of the necessity, caused by the introduction of motor traffic, of relieving local bodies of the increased cost of road maintenance, which they possessed insufficient resources to meet. The board is appointed by the government and is financed by taxation on motor spirit and the payment for licenses for motor cars, amounting together to about $2,900,000 per annum. The board is empowered, with the approval of the treasury, to make advances to county councils and other county authorities for the construction of new roads, or the improvement of existing roads, and to construct and maintain such new roads as, in the judgment of the board, are required to facilitate road traffic.

The Road Improvement Association, another body dealing with this matter, is a private institution which dates back to 1886, but has greatly enlarged its operations and usefulness since the beginning of what may be called the motor era. To it is greatly due the establishment of the road board, but its progeny has by no means superseded the older body, on which more than 200,000 users of the public highways of Great Britain are represented. The association initiated and carried out the first experiments in England, and it has fostered by every means within its power every development to minimize the dust nuisance. Conferences have been held, discussions and meetings organized, exhibitions supported, papers on various aspects of the highway question read before the learned societies by members of the council of the association, and every possible opportunity of raising the matter to one of foremost importance in order to gain for it the attention it deserves has been utilized. Its resources as a central intelligence department upon all subjects relating to the construction, maintenance and administration of the highways have been placed at the disposal of the public.

The exhibition referred to comprised four classes—one for materials and machinery; another for vehicles for the transportation of road materials, wheels and tires, lamps and illumination; a third for statistics, meteorological records, and sections of road construction, old and new; and a fourth for historical data.

Class 1 of course attracted the attention of the visitors most. Here were found specimens of all the principal materials and methods, covering the various binding agents, the sheet asphalt coatings, and spraying materials, with which most highway engineers are familiar.

Wood paving, so extensively used in London, was not represented to the extent that its importance in city work might seem to warrant. London has easily the greatest concentrated traffic of the world, and we find that while the more crowded streets laid with wood require relaying in ten or twelve years, on several main arteries of the town this class of surface lasts twice this period, and it seems to be the ideal one for such traffic as London has to deal with. The Improved Wood Pavement Company, which has largely furnished the work, uses soft wood creosoted, and there has been much difference of opinion as to the relative merits of this and of hard wood. The hard woods naturally last longer, but in the English climate they have been found to be dangerously slippery in damp weather. On the other hand, the soft woods are less noisy, have been found to last better than at first supposed, and the drawbacks due to their absorption of objectionable matter are disappearing with the gradual disuse of animal traction. In many cases hard wood in streets has been superseded by soft wood. It seems strange that wood has not been adopted for sidewalks, as giving much more ease and comfort to pedestrians, owing to greater softness and elasticity as compared with flagging or asphalt.

Wood pavements which are much older than motor locomotion do not seem to have been greatly affected by it as regards surface wear, though their foundations had to be strengthened. The last report of the metropolitan committee on the materials and means of paving the streets of London contains much information, from which it appears that the bulk of the paving laid down last year in the districts covered by the report consisted of creosoted soft wood, though large areas of tar macadam were laid in some districts, principally in business and residential streets with limited traffic. A large amount of tar spraying also was undertaken.

Since the adoption of the latter method considerable saving was effected in several quarters in the cost of scavenging, watering, and maintenance, and it was generally agreed that it brings about a great improvement in the roads. This committee received a number of replies in response to an inquiry as to whether motor traffic has had the effect of increasing the cost of paving and maintenance. In most cases the answer is in the affirmative.

Many surveyors report that they are finding it necessary to increase the depth of the concrete foundations. In Bermondsey, for instance, while concrete 6 in. deep was formerly sufficient, the depth is now being made 9 in., or even 12 in. In Hackney foundations which were sufficient a few years ago are now found inadequate, and in new work the concrete is being made 50 per cent thicker. The Hampstead surveyor considers that the life of wood paving has undoubtedly been reduced by one or two years, and it has become necessary to increase the thickness of the concrete foundation from 6 to 9 in. In Holborn cement foundations 12 in. thick are being laid in places where a thickness of 6 in. was sufficient ten years ago. In Paddington concrete from 10 to 13 in. thick is being used on wood-paved carriageways where the thickness was originally about 7 in., and in Westminster the specification now used, when new foundations have to be laid, provides for 8 in. of concrete. On the other hand, the Fulham surveyor states that motor traffic has had the effect, if anything, of decreasing the cost of maintaining wood-paved roads. It soon discloses the weak spots, and the immediate repair of these appears to increase the number of repairs, but the life of the wood paving is considerably increased, and more than compensates for the increased cost of repair. On water-bound macadam roads in Fulham motor traffic has caused considerable wear and has disintegrated the surface, but the roads so affected have been remade with bituminous macadam, with the result that the cost of maintenance of such treated roads now submitted to motor traffic is not more—perhaps less—than of the water-bound surface before motor traffic came upon it.

In Finsbury the surveyor cannot say that motor traffic has increased the cost of road maintenance, and in Westminster, while the engineer is of opinion that the increase of motor traffic affects macadam roads, and perhaps to some slight extent asphalt roads also, he does not think that as a result of motor traffic there has been any increase in the cost of maintaining paved roads originally laid on present approved methods. The Hammersmith surveyor considers that on wood-paved roads time will show decreased cost of maintenance, since the life of the wood will be slightly lengthened; but on all other roads the expense is largely increased. These all refer to various districts of London.

Among the visits paid by the members of the congress the most interesting, perhaps, was that to the National Physical Laboratory at Teddington, Middlesex, which is a government institution, providing for experimental tests in all departments of constructive work in connection with engineering and naval architecture. A special device there which greatly engaged the attention of the visitors was that invented by Colonel Crompton, the secretary and consulting engineer of the road board. This is a testing apparatus for road surfaces, which is incidentally one also for various types of rubber tires. Circular concentric tracks of water-bound macadam, made up in many different ways, are laid, and upon this a similar number of variously weighted motor wheels are mounted on a radial axle pivoted at the center of the circular tracks. The axle is driven by motors at any speed required. By means of this it will be possible to arrive rapidly at conclusions with regard to the wear of the surface and of the tires. Otherwise it would take years to reach conclusions by actual observations on ordinary roads of the same surfaces. The conditions of weather as affecting the test is imitated by throwing sprays of water on the tracks during the experiment, or blasts of hot air. Colonel Crompton, in a paper read recently before the Institution of Automobile Engineers, gave some valuable hints on the best construction of road surfaces. He showed that the chief source of mud and dust found on roads arose from the interattrition of the stones of which macadam thoroughfares are composed, and far from the wear of road materials being confined to the upper surface, the whole surface of each stone composing the roadway was ground away. All improved pavements, therefore, should have for their object the reduction of that interstitial wear. Tar to the extent of 22½ lb. to the square yard enabled the voids in the surface of the macadam to be filled. Slag was better than broken stone for the subsurface. The pitch grouting, introduced by the road board, was a success. The metalling was rolled dry, but not to the extent of closing the voids, which were filled with a hot binder of pitch, melted and mixed with an equal quantity of hot sand. The Thames Embankment Road had a 1¼-in. bitumen carpet above the metalling, which was pitch-coated macadam, and this was found to give favorable results.

Owing to the great extent of concentrated traffic in London, it is wise for us to look there for the best methods of meeting the difficulty of road wear and tear.

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